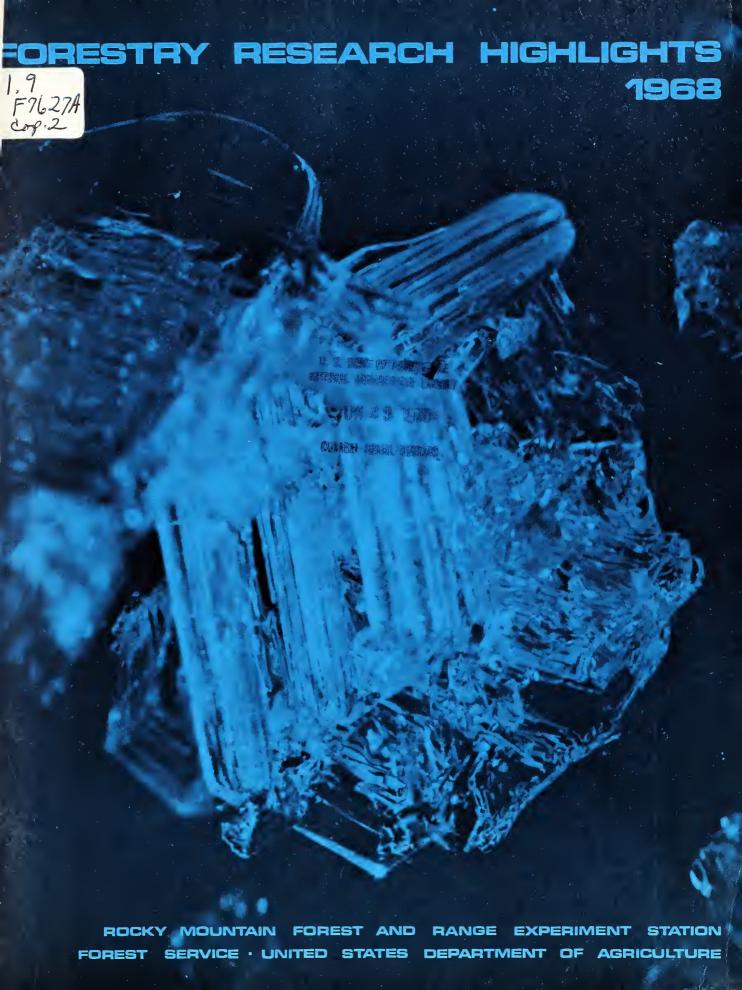
#### **Historic, Archive Document**

Do not assume content reflects current scientific knowledge, policies, or practices.



#### PROJECT LOCATIONS

Albuquerque, New Mexico New Federal Building

Bottineau, North Dakota Shelterbelt Laboratory North Dakota School of Forestry

Flagstaff, Arizona Forestry Sciences Laboratory Northern Arizona University

Fort Collins, Colorado 240 West Prospect Colorado State University

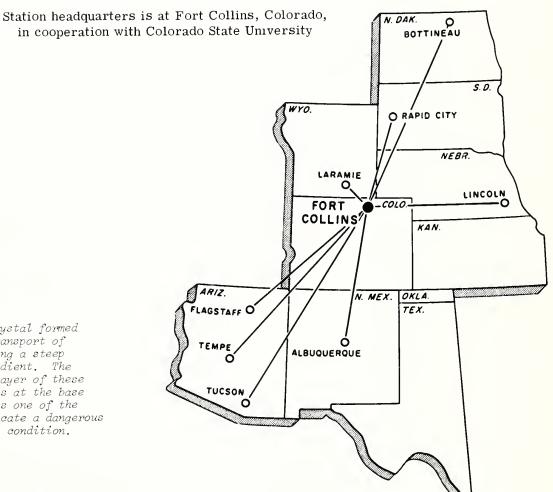
Laramie, Wyoming Forest Range and Watershed Laboratory University of Wyoming

Lincoln, Nebraska Plant Industry Building University of Nebraska

Rapid City, South Dakota Forestry Sciences Laboratory South Dakota School of Mines and Technology

Tempe, Arizona Forest Hydrology Laboratory Arizona State University

Tucson, Arizona Tumamoc Hill University of Arizona



#### ON THE COVER:

A depth hoar crystal formed by the rapid transport of water vapor along a steep temperature gradient. The presence of a layer of these fragile crystals at the base of a snowpack is one of the keys which indicate a dangerous avalanche-prone condition.

# FORESTRY RESEARCH HIGHLIGHTS 1968

ANNUAL REPORT

ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

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#### A brief summary

Watershed Management Research.—Twenty-eight years after timber was harvested, snow distribution on plots in the Fraser Experimental Forest, Colorado, is still being controlled by the aerodynamic effect of the surrounding old forest canopy. Original increased snowpack in the created openings has been maintained, even though abundant reproduction is now about one-third the height of the surrounding uncut forest.

On the Routt National Forest in Colorado, we are measuring the conversion of the snowpack to streamflow and how weather modification of the winter snowfall affects streamflow.

In an attempt to understand the hydrology of the windswept plains in Wyoming, seven small watersheds near Saratoga have been selected to study the hydrologic characteristics of sagebrush lands.

Work in the chaparral areas of Arizona continues to show increases in water yield after the conversion of chaparral to grass. Results indicate that when annual precipitation is only 18 to 20 inches, water yield is correspondingly about 2 inches. As precipitation increases, the proportion removed as streamflow increases until, at about 35 inches, most of each additional inch of precipitation becomes an extra inch of water yield.

In the ponderosa pine type in Arizona, streamflow measurements following timber harvesting in clearcut blocks indicate increased water yield.

Special studies on avalanche forecasting, new methods of measuring streamflow, snow crystallization, forest aerodynamics, characterization of watershed microclimates through the use of solar radiation, and geophysical measurements as they relate to water yield, are some of the many special studies being conducted to assist in evaluating the factors that influence water yields from watersheds.

Timber Management Research continued to emphasize (1) regeneration practices for spruce-fir, mixed conifers, and southwestern ponderosa pine, (2) management procedures for ponderosa and lodge-pole pines, (3) tree improvement for Black Hills ponderosa pine, and (4) environmental improvement on the Great Plains.

Clearcut strips on the Fraser Experimental Forest in central Colorado restocked satisfactorily with spruce and subalpine fir where advance reproduction was saved. Only ponderosa pines more than 20 inches in diameter proved to be good seed producers on the Long Valley Experimental Forest, Arizona. Antitranspirants had no influence on the use of water by ponderosa pine seedlings when soil moisture was low.

Standard levels of growing stock were defined for ponderosa pine and a "rule of thumb" was developed to guide their application by thinning crews. The area covered by the crowns of thinned young ponderosa pines expanded 35 to 40 percent in the first 5 years after thinning.

Diameter growth of Siberian elm seedlings was proportional to growing space in a North Dakota nursery. It was found that a maximum of 45 usable seedlings can be grown per foot of row.

Forest Fire Research emphasized prescribed use of fire in Arizona chaparral and the development of a national fire-danger rating system.

Measurement of the energy released by burning chaparral was sufficiently accurate to demonstrate a close linear relation between weight of fuel consumed and energy output. Flaming combustion of fuel is reduced by ash content, and the percent of ash was found to change markedly with the seasons. Moisture content of chaparral litter correlated more closely with the litter moisture factor of the two-index system of measuring fire danger than with other indexes tested.

Equations were developed for expressing the drying of dead forest fuels in relation to time. It appears that dead fuels may need to be divided into three size classes for purpose of national fire-danger rating. The national fire-danger rating system is intended to include three indexes: a fire occurrence index, a burning index, and a preparedness index.

Forest Insect Research concerned studies of bark beetles, defoliators, and insects of shelterbelts.

It was found that the development of the flight muscles can be used as a guide to impending emergence of mountain pine beetles. From 1/5 to 1/8 of the female beetles emerging from brood trees were found to have been mated. These are believed to be female parents of the emerging brood. A parasite fly, Medetera aldrichii, is largely responsible for mortality of mountain pine beetle populations in winter.

A rapid method of estimating density of eggs of the western budworm permits more accurate estimates of populations and population trends. An improved method was also developed for predicting degree of defoliation by the budworm.

Forest Disease Research found that the lodge-pole pine dwarf mistletoe often replaces the ponderosa pine dwarf mistletoe beyond the northern limits of the latter species in the ponderosa pine forests of northern Colorado. Studies of the chromosomal and flowering characteristics of the dwarf mistletoes were completed and will be especially useful in taxonomic revision of the genus Arceuthobium. Severity of symptoms of an unexplained disease of ponderosa pine in the Denver area is directly correlated with the concentration in the foliage of both sodium and chloride ions.

Nursery beds infected with root-lesion nematodes produce more and larger pine seedlings if fumigated with methyl bromide. Three chemicals commonly used to protect seeds from fungi, birds, and rodents will impair germination if too concentrated.

In Range Management Research, 7 years of grazing range seeded to Sherman big bluegrass showed that grazing to a 4-inch stubble is about proper use. Guides are now available for grazing five grass species seeded on granitic soils of the Front Range of the Rocky Mountains: Sherman big bluegrass, intermediate and crested wheatgrasses, smooth brome, and Russian wildrye. Grazing high mountain grassland at rates ranging from 19 to 48 percent use of the main forage species for 10 years made little difference in either vegetation or cattle weight gains.

In the Snowy Range, Wyoming, removing low-value golden avens from alpine sheep ranges with 2,4-D adversely affected the most desirable sheep forage. Emphasis continues on determination of the quality of major plants in ponderosa pine and chaparral in the Southwest as forage plants for cattle.

An entirely new phase of research was started to determine ways to identify and interpret changes in range vegetation through the use of large-scale color-infrared aerial photography. Some other investigations underway include herding versus not herding sheep on alpine range, encouraging rapid range recovery in ponderosa pine ranges, techniques for planting shrubs in the arid Southwest, coordinating timber thinning with cattle production in ponderosa pine forests, comparing values for chaparral under natural conditions and when converted to grass, and several aspects of improving and managing semi-desert cattle ranges.

Wildlife Habitat Research continued to emphasize the improvement and management of (1) mule deer and elk ranges in the central Rocky Mountains, (2) game ranges on the National Grasslands and in the Black Hills, and (3) wildlife habitat types of the Southwest. In the Southwest, this research is directed to developing guidelines for coordinating wildlife habitat needs with other land use activities, especially timber harvest, treatments to increase water yields, and grazing by livestock. Through these projects, we intend to gain an understanding of (1) habitat requirements of the various game animals, (2) how well these habitat requirements are met by existing conditions, and (3) what adjustments in land-use practices are needed to provide the habitat requirements.

Forest Economics Research continued working to develop sound information and analytical methods for multiple use planning and management decisions. An interdisciplinary team of economists, foresters, hydrologists, plant ecologists, wildlife scientists, and others continued evaluation of land management and treatment practices designed to increase streamflow on the Beaver Creek Watershed Evaluation Project in northern Arizona.

Uprooting Utah juniper trees with a cable pulled by heavy tractors, a common range improvement practice, has been commonly believed to improve water yields. A test of juniper cabling at Beaver Creek in northern Arizona, however, showed no real change in either streamflow or sediment yield. Another test involved felling alligator juniper with saws to avoid disturbing the soil or creating pits. So far, 3 years after treatment, there has been no real change in yields of either water or sediment.

Data on costs of land treatments tried on pilot watersheds are being analyzed to provide a valid basis for estimating costs of full-scale operations, and to determine ways of doing the work more efficiently and at less expense.

Scientists found it necessary to design a new stream gage that would permit precise measurement of discharges from 1 to 1,000 cubic feet per second, and also be self cleaning. This new design has proven successful in northern Arizona, and is being used elsewhere.

Research in Forest Products Utilization continues to be focused on development of new or improved products from softwoods in the Central Rockies and the Southwest.

A pilot-plant test of upgrading low-value ponderosa pine lumber with fiber overlays is continuing. Tests indicate that the process is feasible, but that knotholes and other open defects seriously limit its use. Foam-type resins for filling the holes offer some promise, but other repair methods are being considered.

Technical requirements for composting bark are being studied. It has been found that adding nitrogen to the bark speeds up decomposition and improves the carbon:nitrogen ratio. Finding a use for bark that commonly is burned will contribute to the effort to lessen air pollution.

Traditional sources of naval stores are declining. Preliminary studies indicate that ponderosa pine stumps in the Southwest can yield naval stores, although some additional refinement will be necessary.

In cooperation with industry, weight scaling was thoroughly field tested. Weighing loads of logs is faster and cheaper than conventional stick scaling. The field test resulted in a computerized set of weight-scaling tables that promises to be useful.

Continued work on logging costs and productivity shows that size of trees is a major factor influencing logging production rates and costs.

Research in Forest Products Marketing.—Continuing analyses of national markets for plywood showed that plywood production in the South grew from about 3 percent of the national total in 1965 to about 10 percent in 1966. Southern pine plywood continued to be marketed mostly in the South, East, and Lake States areas where it has a freight advantage over that shipped from the West Coast.

A study of plywood distribution in Arizona showed that, although some plywood is purchased directly from the mill by users, most is channeled through wholesalers. Also, preliminary indications are that use of plywood in home building in Arizona has increased by about 40 percent in only 4 years.

A comprehensive series of studies is underway to determine the technical and economic feasibility of plywood production in the Black Hills area. The first study has shown that Black Hills ponderosa pine yields a good quantity and quality of veneer for sheathing-grade plywood.

In connection with the pilot-plant tests of upgrading ponderosa pine lumber with fiber overlays, a study of the marketability of overlaid products showed that molding and siding hold the most promise of 20 prospective products considered.

Details of these and other findings are presented in the following pages. Complete accounts of our research are released through various publications. An annotated list of publications issued in 1968 is included in the bibliography at the end of this report.

Raymond Price, Director

Watershed Management Research

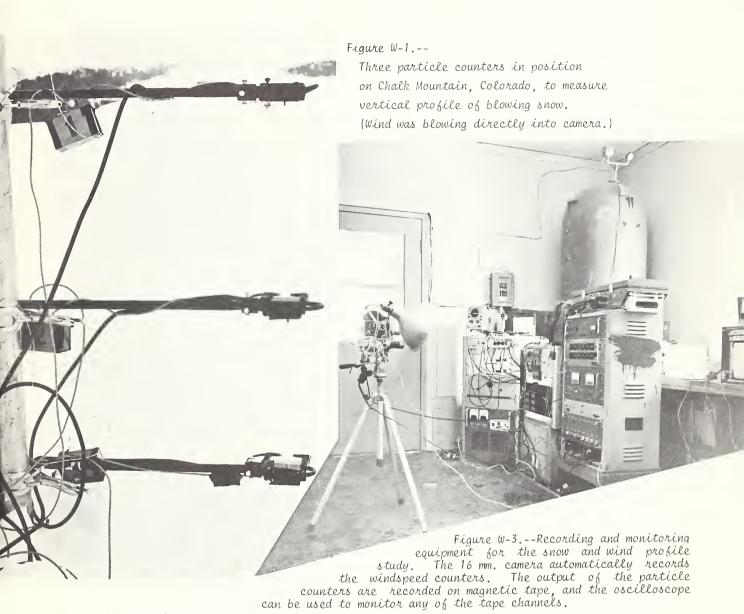


Figure W-2. --

Instrumentation setup for wind and snow profile study on Chalk Mountain, Colorado.

Bi-vane (far left) measures vertical and horizontal components of the wind. Three particle counters (between the men) are mounted at ends of the horizontal bars. Metal cylinder with conical opening is a snow trap for measuring fall velocity of snow particles. Nine sensitive anemometers, to measure the vertical wind profile, are mounted on the tower.

## Photoelectric snow-particle counter developed

A snow-particle counter (fig. W-1) was developed to measure the concentration of snow in the air at various levels over mountain ridges. It is necessary to know the concentration of snow in the air during blowing snowstorms to test various theories which predict snow-trapping efficiency of ridges and snow fences. Other applications would include the development of an accurate precipitation-measuring system, and of various types of blowing snow-intensity meters (figs. W-2, W-3).

The photoelectric snow-particle counter counts and measures velocity of individual snow particles. The essential components of the counter are a light source which produces a narrow, high-intensity beam, and two light-sensitive diodes which have fast response times. When a snow crystal is blown through the active volume of the counter, it shadows the diodes successively. The diodes are connected to an associated amplifier such that shading the first diode produces a positive signal, while shading the second produces a negative signal. The active volume is small enough so that it is very unlikely that more than one snow crystal will occupy the volume simultaneously. The output of the amplifier is recorded on tape.

The instrument was field tested during a storm on Chalk Mountain, in the San Isabel National Forest near Leadville, Colorado, on March 26, 1968. Although it appears to be more complicated than some of the other forms of snow traps, it is actually much easier to use since, once the instrument is in place, it requires no further handling or attention. Furthermore, it is more accurate than snow traps because it counts all of the particles passing through the active zone. The small size also causes a minimum of airstream interference.

## A new approach for predicting snow fracture

Knowledge about how snow fractures is badly needed to develop accurate prediction schemes for avalanches. Bulk properties of snow have not yet been used successfully in developing such schemes. The fact that snow under slab avalanche conditions, fractures in a brittle manner (fig. W-4) suggested that some of the recent work on brittle fracture mechanics might be applied to snow and a realistic failure criteria developed.

An analogy with glass fracture appears particularly promising in that many of the fracture surface features which occur in glass are also found on the fracture surfaces of slab avalanches. These features result from the fact that, as a crack propagates in a brittle material, an increasing amount of elastic energy becomes available for crack propagation; after the crack has accelerated to a limiting velocity (approximately the speed of sound), the excess energy is used in forming branching cracks (fig. W-5). The

Figure W-4.--

Markings on the fracture face at the left show that the fracture definitely started at the rock embedded at the bottom of the face (arrow), and spread to the left.

increasing number of branching cracks leads to an increasingly rough surface. Thus, the smoothest part of the fracture is at the point where the crack starts. The starting points of the failures in slab avalanches and the directions of crack propagation will be useful in evaluating the relative importance of various failure mechanisms.

The glass analogy also suggests two failure criteria. The first is that failure occurs when the elastic energy in the snow layer is large enough to overcome the energy necessary to form new snow surfaces (fracture faces). The second is that failure occurs when the elastic stress is high enough to cause the flaws which exist in the snow layer to enlarge. Once they begin to enlarge, the stress becomes concentrated at the flaws and leads to failure. These hypotheses will be tested during the winter of 1968-69 at Berthoud Pass in Colorado and some other selected sites.

Figure W-5.--Fracture face showing the transition from a smooth surface to a rough one as the crack accelerated to its limiting velocity (dotted line). This fracture was caused by the sliding of the snow layer above and, as would be expected, the marking shows that the fracture was initiated at the surface of this particular layer.





Hydrologic evaluation of weather modification requires snow-proof stream gages

The crest area of the Colorado Rockies is a major water source, but perhaps can be even more productive. Winter cloud seeding could add more snow, and if it does, how will this affect the amount and timing of streamflow? The office of Atmospheric Water Resources, U. S. Bureau of Reclamation, is concerned with the potential of weather modification. The Park Range, between Rabbit Ears Pass and Buffalo Pass on the Routt National Forest, is a pilot target area. We are one of several agencies cooperating in a project there. Our role is determination of the hydrology of the target area and how it may be changed by increased winter snowfall.

Stream gages for high-elevation index watersheds were required. Snowfall records showed that the extremely deep and late-lying snowpack was a real problem. Snow, when runoff began, could be more than 10 feet deep and watersheds still completely snow covered during peak flow. The snow-

free construction season is short and, to make things even tougher, the gages must measure accurately a wide range of flow.

Problems were overcome by use of Cipolletti weirs installed in prefabricated laminated-wood cut-off walls. The stilling pond was covered so that it could operate beneath the deep snowpack without blockage by snow and ice (fig. W-6). Installation of a prefabricated recorder house completed the job.

Stream gaging in the Park Range begins each spring when snow accumulation is at its peak (fig. W-7). Because the gages are covered, it requires only a minimum of effort to make them operable. Since April 1967, we have successfully gaged runoff from three study watersheds with a size range of 1.3 to 3.4 square miles.

Both the amount of snow and the quantity of yield are surprisingly high. For a 2.2-square-mile watershed just west of Buffalo Pass, precipitation was 53 inches and streamflow 44 inches during the 1966-67 water year. The potential for increasing runoff by addition to winter snow is exceptionally great.



Figure W-6.-Covering of the
weir pond reduces
snow shoveling
to open the stream
gage in the spring,
and minimizes ice
problems. This
gage is designed
to measure up to
225 cubic feet
per second.



Figure W-7.--The roof of the instrument shelter at this stream gage in the Park Range is barely visible in the 10 feet of snow typical of this area in the spring. Streamflow reaches its peak when this watershed is still completely snow covered.

Aerodynamics effect is major cause of increased snow on harvest plots

On the Fraser Experimental Forest, Colorado, a series of replicated plots was established in old-growth lodgepole pine to test the influence of five different stand densities on snow accumulation. Snowpack was measured in 1938 and 1939, and then plots were cut so that the residual volume in trees larger than 9.5 inches diameter breast height (d.b.h.) was in these classes: 0, 2,000, 4,000, or 6,000 board feet (ft.b.m.) per acre. The uncut stand contained 11,900 ft.b.m. per acre. After cutting, snowpack measurements were repeated in 1941, 1942, and 1943.

<sup>1</sup>Common and scientific names of animals and plants mentioned are listed on p. 62. Those for diseases and insects are included in text since many are identified only by their scientific names.

Young trees developed rapidly on the 0 and 2,000 ft.b.m. reserve plots. By 1956 the young trees averaged 5 feet in height, which placed their upper canopy above the snow surface; by 1964 their average height was 15 feet. Stocking on the 0 ft.b.m. plot was 79 percent, and on the 2,000 ft.b.m. plot 74 percent. On each group of plots there were 4,000 trees less than 4 inches d.b.h. There has been least change in canopy density on the 4,000 ft.b.m. reserve plots, and little change on the denser plots. Heavy windfall on the 2,000 ft.b.m. reserve plots reduced overstory density between 1940 and 1968.

Snow storage amounts have changed little, if any, with time since cutting in spite of the considerable regrowth of young trees and increased canopy density on the heavily cutover plots (fig. W-8). This finding indicates no increase in evaporative losses in spite of greater exposure of snow on canopy surfaces.



Figure W-8.-New growth does not
affect total snow storage
in this lodgepole pine
area of the Fraser
Experimental Forest.
This 8-acre plot,
cut 28 years ago to
remove all but 2,000
ft. b.m. of trees
larger than 9.5 inches
d.b.h., still functions
as an opening with wind
controlled by surrounding
old-growth forest.

These results indicate that the aerodynamic effect on snow distribution is the major cause of increased snow in the harvest plots. Despite the abundant reproduction on the heavily cut plots, which is now almost one-third the height of the surrounding uncut forest, the new trees are not yet influencing snow distribution, which is still controlled by the arrangement of the taller old-growth forest surrounding the plots.

## Heated thermistors measure windspeed in forest canopy

Heated thermistor anemometers, which are less expensive and less sensitive to orientation than conventional sensitive-cup anemometers, were designed to measure air moving in, below, and above the forest canopy (fig. W-9). This air movement controls snowpack distribution and evapotranspiration.

The instrument consists of two bead thermistors heated to about 120°C. One bead is exposed to the local airflow, while the other is shielded by the housing. These thermistors measure windspeed by differences in voltage output in an electrical bridge circuit. By intermittent operation, the unexposed thermistor also may be used to measure air temperature.

Six anemometers are mounted at 5-foot intervals on each of two mobile telescoping 30-foot masts (fig. W-10). Two other such instruments, as well as extra temperature sensors, a wind cup, and a wind vane are located at three levels above the tree canopy on a larger fixed tower. The voltage output of the anemometers can be monitored and "smoothed out" in an instrument shelter away from the area to avoid any disturbance.

The vertical wind profile at a particular point in the stand varies primarily with windspeed and direction, and change of windspeed and temperature with height above the canopy. Windspeed and temperature profiles are measured at intervals over a 1- or 2-day period to sample a fair range of above-canopy conditions.

#### Geophysical measurements and diamond-core drilling provide basic water-mantle information

The methods of exploration geophysics—seismic refraction and electrical resistivity profiling—are being used to characterize the "water mantle" of the Sturgis watersheds, Black Hills, South Dakota. The mantle is laccolithic (quartz monzonite porphyry) in origin, and is so rocky that customary soil sampling and augering are not possible. Correlations with diamond-core drilling at selected points indicate seismic detections of a low-velocity rock-soil layer on weathered, fractured bedrock of high velocity which increases with depth. The drilled cores revealed horizontal fractures near the surface, with vertical joints more common at greater depths.



Figure W-9.-Thermistor anemometer.
The exposed
thermistor bead is
the small dot.

Figure W-10.--An array of five thermistor anemometers is placed on a 30-foot telescopic mast, which is moved to sample locations within a lodgepole pine stand.



Infiltration and percolation are high in the surface rock-soil layer, with high detention capacity but low retention capacity. Specific yield of the bedrock is comparatively low and decreases with depth. These mantle properties control the nature of streamflow discharge from the watersheds. Ground-waterlevels and flow stages both respond quickly to heavy

spring and early summer precipitation and recede rapidly to a low base-flow level.

We foresee that systematic study of mantle properties with improved geophysical instruments and techniques, correlated with detailed core and ground-water measurements, will improve small watershed analyses.

## Pressure-chamber technique for determining water stress

The pressure-chamber technique of determining an index to internal plant-water stress has literally been labeled the "bomb" because of the physical appearance of the cylinder in which dissected branches are placed (fig. W-11). Dry nitrogen is introduced into the cylinder with increasing pressure until liquid sap flows from the cut stem portion that protrudes out of the cylinder. Pressure at which the sap first appears at the cut end of the branch is related to the tension or stress exerted by the plant cells. The technique is particularly suited to field conditions because of rapidity of measurements and low cost of equipment.

The technique gives repeatable data; relative water relationships and site characteristics within and between species are clearly discernible. Knowing the environmental conditions and physiological potentials of a species with respect to water availability greatly aids interpretations made by foresters and plant ecologists.

In a test conducted on the Castle Creek watershed in Arizona the pressure-chamber technique detected changes in plant-water stress between a thinned and unthinned stand of ponderosa pine. Pressure-chamber data were highly correlated with incoming solar radiation, air temperature, total soil moisture, and relative sap velocity.

#### Surface peat provides rapid drain out to streamflow

Drainage characteristics of peat from a Wyoming mountain bog change rapidly with depth. Moderately decomposed surface peat from 0 to 13 centimeters (cm.) deep yielded 0.35 cubic centimeters (cc.) of water per cc. of peat, between saturation and 0.33 bar suction. Decomposed material from a 36 to 48 cm. depth lost 0.20 cc. water per cc. of peat. Peat contains 80 to 85 percent water at saturation, but the larger voids of surface peat readily drain at low suctions in contrast to reduced flows from the smaller voids within decomposed material. This information, added to that concerning ground-water relationships, stream-water quality, and evapotranspiration measurements, will help demonstrate how mountain bogs affect streamflow timing and water quality.



Figure W-11.-Dry nitrogen is released into the small pressure cylinder ("bomb") until sap runs out of the cut twig. The technician has the twig inserted in the lid of the bomb and is ready to place the twig into the cylinder. The ring in his right hand will seal the lid.

Runoff and sediment not affected by modern grazing practices on high mesa ranges

Measurements since 1957 fail to show any direct relationships between bare soil exposed and runoff and sediment on three watersheds each in grass, aspen, and spruce-fir types typical of high mesas of Colorado. Although bare intercept has shown a significant declining trend over the years, there has not been a reduction in sediment. Runoff is highly correlated with precipitation, but the addition of bare soil hits to the regression does not significantly decrease the "unexplained" variance.

All three watersheds are parts of larger pastures on Black Mesa where grazing is controlled to 25, 55, and 60 percent utilization of Idaho fescue. This grazing has not led to any severe depletion in vegetative ground cover. Ninety nine percent of total yearly runoff and 80 percent of sediment production are recorded during spring snowmelt (fig. W-12), and the protective aspects of vegetation may have a minimal influence.

Suspended sediment from small watersheds can be predicted

On the Beaver Creek Watershed Evaluation Project in Arizona it was found that the concentration of sediment suspended in a stream below an untreated watershed could be predicted from information about rate and stage of the stream, elevation of the watershed, and the percentage of the watershed covered with plant litter.

Suspended sediment is an indicator of soil loss from the watershed and of water quality. Measuring changes in sediment yields after watershed treatments is an important step in making multiple use and economic evaluations.

Figure W-12.--Snowmelt water flowing over the soil surface on Black Mesa, Colorado. This picture was taken 2 days after the spring peak. Note the gopher casts and how they are washed out when in a watercourse.



Radiation indexes may aid in prescribing watershed treatments

A study now in progress on the West Fork of Castle Creek in northern Arizona should lead to prescribing treatments for desired water yield. Precipitation, soil moisture, and radiation indexes are being measured at single points for (a) forest, (b) clearcut block, and (c) cienega. Solar radiation (short wave) is measured above the canopy of the surrounding trees, and net (all-wave) radiation is measured at a sufficient height above the plot vegetation to obtain average conditions for a 300-foot-diameter area. One-hundred-foot telescoping towers (fig. W-13) have been installed at each of the three sites, along with battery-operated integrators in heated shelters.

The underlying premise for this study is the accumulating evidence that net all-wave radiation and evapotranspiration are closely correlated when soil moisture is not limiting. To extend this work to include cases when soil moisture is playing a dominant role, field moisture and the tension by which it is held will be measured and used along with net radiation in multiple regression analyses.

With this type of information available, quantitative characterization of the watershed microclimate in terms of its radiant energy level should enable us to prescribe vegetation treatments to increase water yields.

Soil-applied fenuron and picloram control brush on chaparral watersheds

Pelleted fenuron and picloram are useful herbicides for controlling chaparral brush, as shown by spot-treatment hand applications on two experimental watersheds in Arizona. Picloram and fenuron were applied at intended rates of 8 and 16 pounds active ingredient per acre, respectively. Picloram was tested at half the rate of fenuron because of its high herbicidal activity and high cost.

Picloram, at half the rate of fenuron, was more effective than fenuron on birchleaf cercocarpus, sugar sumac, and yellowleaf silktassel, but less effective on shrub live oak and Emory oak.

Figure W-13. --

Telescoping towers, 100 feet high, (arrow) have been installed to measure solar and net radiation above the canopy of the surrounding trees.

The portable instrument trailer has its own power supply with an auxiliary standby plant that automatically supplies power if the main plant fails.



Because of specific toxicity differences, and because the necessary rates of either herbicide to control all of the shrub species is excessive, a duoherbicide treatment is an interesting possibility when hand applications are feasible. Picloram and fenuron could be applied singly to the shrubs most sensitive to each herbicide to achieve broad-spectrum brush control. Each herbicide could be used at the lowest rate commensurate with adequate control.

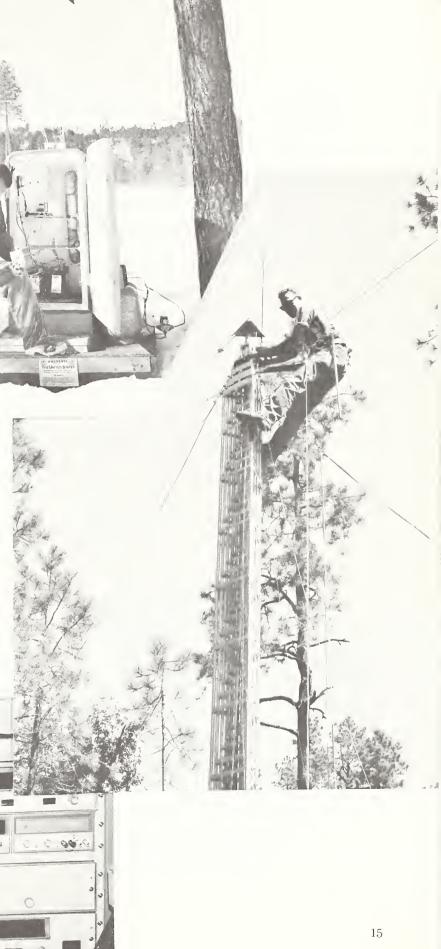
Readings are taken from the radiation integrator inside the heated instrument shelter.

In the cranked-down position, the radiometers at the top of the 100-foot towers can be serviced at 20 feet above ground level.

Inside the trailer, are the card punch (left) and the electronic data logger (right).

The data logger automatically scans 36 data channels at pre-set intervals of from 1 to 60 minutes.

Its full capacity is 120 channels of information.



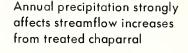
Water yields increase after harvest of ponderosa pine in Arizona

Preliminary measurements indicate increased water yields following a harvest of ponderosa pine on the West Fork of Castle Creek in northern Arizona.

Timber harvest, started in the spring of 1965, included clearcutting one-sixth of the watershed in blocks fitted to the overmature and dwarf mistletoe-infected tree classes (fig. W-14). The remainder of the watershed was placed in the best growing condition possible.

Comparison of the first 2 posttreatment years with the pretreatment regression indicates significant increases in water yield. The increase was smallest during 1967, a year of less-than-average streamflow, and highest during 1968, a year of higher-than-average streamflow. Final indications of treatment effects will require additional years of measurement.

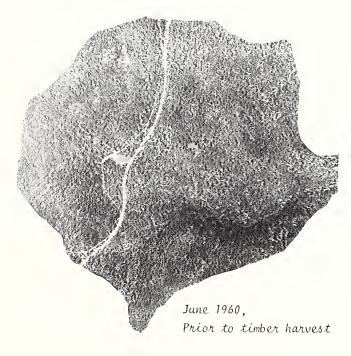
Figure W-14.-Aerial photographs
of West Fork
of Castle Creek.

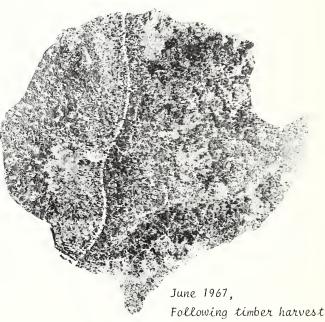


Increases in streamflow are directly related to the annual amount and distribution of precipitation on a 95-acre chaparral watershed in central Arizona that was converted to grass after the dense oak brush cover was consumed by wildfire in 1959. Precipitation over the watershed averages about 25 inches per year, but varied from 18 to 36 inches since 1962.

Measurements indicate that, when annual precipitation is only 18 to 20 inches, the grassed watershed produces roughly 2 inches of extra water. As the precipitation increases, however, a larger proportion of the precipitation is recovered as streamflow, and this proportion continues to increase until most of each additional inch of rain becomes extra water yield. On this grassed watershed, this point may be reached at around 34 inches of precipitation.

These results indicate that some minimal precipitation level exists below which little increase in water yield due to chaparral conversion can be expected; that level may be around 15 inches at the site of this experiment. The efficiency of the treatment for producing extra water improves with increasing annual rainfall up to at least 34 or more inches. One wet year may produce as much extra water as several dry years.





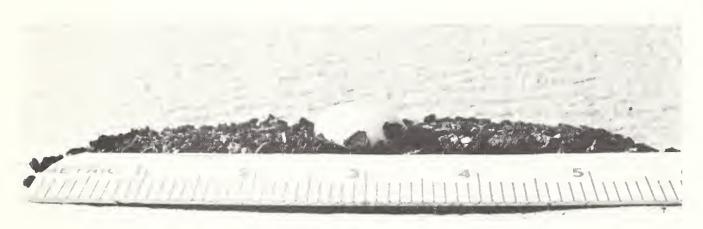


Figure W-15.--A drop of water (with tracer added) shows the resistance of Utah juniper litter to wetting.

## Nonwettable soil found under Utah juniper

Both litter and the mineral soil were found to be nonwettable under clumps of Utah juniper in central Arizona. Drops of water applied to the soil surface require more than 1 hour to completely disappear (fig. W-15). The litter showed strong resistance to wetting, while wettability improved with depth in the mineral layers. The bare soil in open areas between clumps was completely wettable, requiring less than 1 second for a drop of water to disappear.

These striking differences in soil wettability may significantly influence the hydrology of Utah juniper sites.

## Streamside control of chaparral increases water yield

A streamside strip in central Arizona was chemically treated to convert a chaparral cover to a grass cover. The vegetation treated was not what is ordinarily thought of as riparian, but hillside brush species (mostly shrub live oak and cercocarpus) that extend into the channel bottoms (fig. W-16). Scattered junipers not chemically treated were girdled or felled.

All areas within 30 feet vertical distance (but generally not exceeding 75 feet horizontal distance) from stream channels exhibiting more than an occasional surface flow were treated. Approximately

Figure W-16.--Section of valley bottom on Whitespar B watershed in Arizona prior to poisoning of the brush on the streamside strip.

37 acres or 15 percent of the total watershed area was treated.

Streamflow has been continuous since treatment in 1967. Two summers have passed, and in both summers, flow in the control watershed has stopped for periods up to several weeks. Prior to treatment, timing of streamflow in the two watersheds was similar. About two-thirds area-inch of streamflow above that expected for pretreatment conditions has been estimated for the first posttreatment year (June 30 - July 1) which contained a winter with exceptional amounts of snow cover. If the increased yield is assumed to have all come from the treated area of approximately 37 acres, it would indicate a treated area increase in runoff of about 4 inches.



Timber Management and Torest Protection Research

#### **Timber Management**

Reproduction good after clearcutting spruce-fir in strips

Where timber was harvested to a 4.0-inch-diameter limit in alternate strips 1, 2, 3, and 6 chains wide on the Fraser Experimental Forest in central Colorado, enough trees survived logging in 1956 to restock all strips. Numbers of seedlings and saplings ranged from 4,183 per acre on the 2-chainwide strips to 5,957 per acre on the 6-chain-wide strips. Composition of surviving advanced growth was predominately subalpine fir.

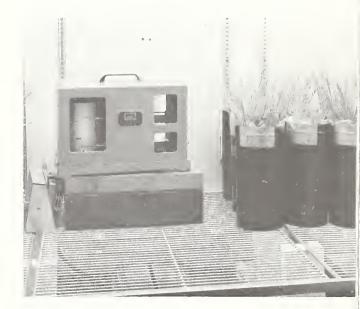
New reproduction added an average of 689 trees per acre to the strips in the first 10 years after cutting. Although number of new seedlings ranged from 345 per acre on the 2-chain strips to 1,365 per acre on the 3-chain, there was no direct relationship between number of seedlings and width of opening. Species composition was not improved by new reproduction. The increase was 70 percent subalpine fir, 19 percent lodgepole pine, and 11 percent Engelmann spruce.

All strips were well stocked after logging; stocking ranged from 76 to 83 percent of the milacres sampled. Although advanced reproduction that survived logging was predominately subalpine fir, Engelmann spruce was well distributed; from 37 to 54 percent of the milacres sampled (average 48 percent) were stocked with spruce. Total stocking increased at about the same rate as new reproduction established after logging, but the increase in stocking was proportionally greater for spruce and pine than for fir. By 1966, from 78 to 88 percent of the milacres sampled were stocked, and spruce was present on 46 to 64 percent of the milacres.

Antitranspirants ineffective in improving drought resistance of ponderosa pine seedlings

Two-month-old seedlings raised under nearly optimal conditions in a controlled-environment chamber were treated with Cycocel, hexadecanol, and Foli-gard as foliar sprays (fig. T-1). Cycocel significantly improved efficiency of wateruse when soil moisture was adequate, but had no effect when moisture was limiting. Height growth was stimulated by the hexadecanol and Foli-gard treatments, but dry weight was unaffected. Limiting soil moisture induced greater drought avoidance and relative drought resistance than any of the antitranspirants. It is unlikely that any of the substances tested would significantly improve seedling resistance to drought.

Figure T-1.--Evaluating antitranspirants on ponderosa pine seedlings in a controlled-environment chamber.



#### Leave large ponderosa pine seed trees for shelterwood

Good seed-producing trees should be favored for retention during the "seed" cutting of the shelterwood system. On the Long Valley Experimental Forest in central Arizona, that would mean trees over 20 inches in diameter. Of the 49,000 cones borne on 265 seed trees during a good seed year, about 96 percent were on trees over 20 inches in diameter. Cone production by dominant ponderosa pines increased with tree diameter.

Production averaged 1,321 cones per acre where 20 square feet of basal area per acre was left, and 2,352 where 40 square feet was left.

Based on an average of 70 good seeds per cone, the expected seed yield should adequately restock the area with new seedlings, provided seed losses to birds and rodents can be minimized, summer precipitation is adequate, and the seedbed is properly prepared.

## Grass more drought tolerant than ponderosa pine

Arizona fescue and mountain muhly withstood drought conditions better than ponderosa pine seedlings in northern Arizona. Roots of both bunch-grasses grew faster and depleted soil moisture to lower levels than did the pines (fig. T-2). Fescue roots started growth about mid-April—nearly 1 month earlier than muhly or pines. By mid-June, new root growth for the grasses was nearly four times that for the pines.

Figure T-2.--Measuring soil moisture depletion by ponderosa pine seed-lings on a 3-foot-square plot surrounded by a black plastic film moisture barrier.

The grasses also recovered faster than the pines following the drought. After rewetting the soil, grasses resumed rapid top growth and developed one or two flushes of new roots, while pines failed to make new top growth and produced only a few new roots.

## Assimilation chambers for measuring photosynthesis

Photosynthesis of plants is commonly determined by measuring carbon dioxide uptake of enclosed plants with an infrared gas analyzer. Two enclosure systems can be used. We found an open system—where carbon dioxide ( $\mathrm{CO}_2$ ) concentration is measured before and after air is drawn over a tree seedling—best for field measurements, and a closed system—where the change in  $\mathrm{CO}_2$  concentration was measured over time—better in the laboratory. Although photosynthesis measurements are simple in principle, problems are encountered when seedlings are enclosed in chambers. Light intensity and temperature must be carefully controlled. In addition, airflow must be accurately regulated in an open system, and a closed system must be airtight.

A plexiglass assimilation chamber (fig. T-3) was successful for field measurements. Temperature was controlled by manually adjusting the flow of cold water through the narrow space formed by double side walls and ceilings of the chamber. This cooling system was sufficient to filter out and dissipate the longwave component of sunlight which was used to illuminate seedlings during photosynthesis measurements. The amount of light reaching the seedlings was simply controlled by placing layers of cheese-cloth over the chambers. The easy construction and low cost allowed simultaneous use of several chambers, which were sampled in sequence with one analyzer.

The plexiglass chamber was unsatisfactory in the laboratory because (1) the water jacket could not dissipate the extreme heat from artificial lights used to develop 12-13,000 foot-candles of light intensity, and (2) the  $\rm CO_2$  content of air varied excessively because of exhalation of persons and exhaust from fuel combustion. Those problems were eliminated by using a closed system to overcome the variable  $\rm CO_2$  content, and a more elaborate cooling and temperature control system to remove heat (fig. T-4).

Most of the heat from seven 300-watt spotlights was removed by a heat filter consisting of a layer of water between the lamps and the chamber. Heat not absorbed by the filter was dissipated by precisely controlled cold water circulating through copper cooling coils soldered to the wall of the plant chamber.

#### Figure T-3.--

Plexiglass assimilation chamber used in an open system to measure photosynthesis of tree seedlings outdoors:

- A, air intake
- B, air outlet to analyzer
- C, water inlet to cooling jacket



Figure T-4.--Assimilation chamber and associated equipment used in closed system to measure photosynthesis of tree seedlings in the laboratory:

#### FRONT VIEW

- A. plant chamber
- B. light source
- C, heat filter
- D. cold water reservoir

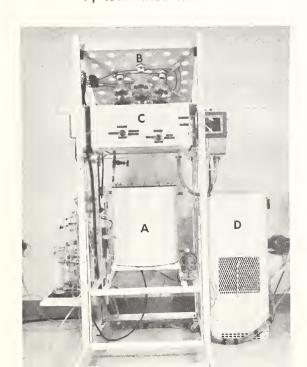
#### SIDE VIEW

A, plant chamber (in loading position)

E, electronic controls

F, proportional valve actuator

G, glassware for drying and humidifying air samples



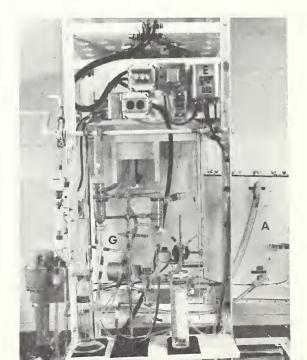




Figure T-5.--Airborne pine pollen was trapped by adhesive on face of cellophane tape, stuck on back of perforated strip of sheet aluminum. Traps were changed weekly to show progress of pollen dispersal.

#### Pine pollen flight in the Black Hills charted

Sampling of ponderosa pine pollen in 1968 to aid in planning for tree improvement studies in the Black Hills of South Dakota showed the following:

1. Dispersal took place from mid-June to mid-July.

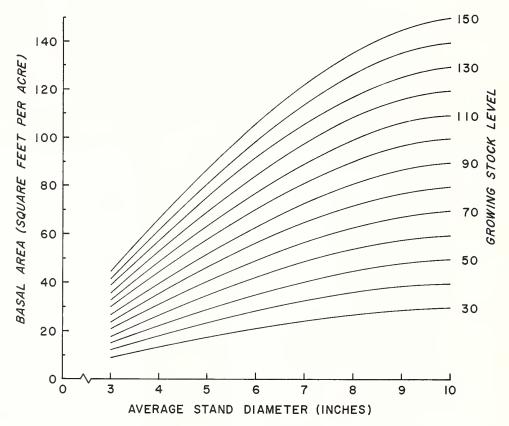
- 2. About 86 percent of the total pollen catch was trapped (fig. T-5) during the last 2 weeks of June.
- 3. Pollen was disseminated uniformly throughout two 400-foot-diameter clearings.
- 4. Total seasonal discharge amounted to 109 billion grains per acre in a clearing surrounded by an 80-year-old stand, and 227 billion grains per acre in a clearing surrounded by mature saw-timber.

## Standard levels of growing stock established by ponderosa pine

Basal areas and average stand diameters were adopted as joint measures of growing stock for a West-wide study of growing stock levels for ponderosa pine. Study stands will be rethinned periodically to a designated "growing stock level." Each level is designated by a numerical index that equals the assigned basal area when stand diameter is 10 inches or more. For stands of smaller average diameter, a residual basal area will be less than the index value, as shown by figure T-6.

These growing stock levels, described in our Research Paper RM-33, are now being adopted to guide precommercial thinning.





## Spacing guide for precommercial thinning of ponderosa pine

A simple guide has been developed for use in thinning dense even-aged ponderosa pine thickets to prescribed "growing stock levels" (see preceding item). To use the guide, the crew member needs only to add the tree diameter "D" in inches to a guide number to obtain the correct spacing in feet. For example, a 5-inch tree at a stocking level of 80 square feet requires a spacing of 5+7=12 feet. Tests on the Coconino National Forest in Arizona have demonstrated that the guide will insure proper retention of trees for different desired stocking levels.

Desired level of stocking (Square feet)	Tree diameter + guide number (Feet)
(Square reet)	(1664)
20	D + 16
30	D + 13
40	D + 10
50	D + 9
60	D + 8
80	D + 7
100	D + 6
120	D + 5
150	D + 4

## Thinned ponderosa pine have rapid crown growth

Rapid expansion of the crowns of thinned ponderosa pine in Northern Arizona points toward complete canopy closure in 10 years on plots with an initial stocking index of 80 square feet or more. Plots with the highest stocking density had the most rapid closure during the first 5 years.

## Conversion of tree heights in logs to heights in feet

Heights of Black Hills ponderosa pines, expressed as the number of 16-foot logs, can be converted

to feet by the following table. The conversion is necessary as a step in converting volumes in board feet to volumes in cubic feet with existing volume tables.

Height in 16-foot logs	Estimated total tree height
(Number)	(Feet)
0.5	44
1.0	50
1,5	55
2.0	61
2.5	66
3.0	72
3.5	78
4.0	83
4.5	89
5.0	95
5,5	100
6.0	106

## Spacing of Siberian elms in nursery beds established

Siberian elm planting stock 16 inches or more tall having stems 7/32 to 14/32 inch in diameter are considered usable for shelterbelt planting. Under usual nursery practices it takes 2 years to produce them

In an effort to produce satisfactory stock in 1 year, newly established seedlings were thinned to 2, 4, 10, 15, and 20 per linear foot of row and compared to unthinned. None of the spacings produced a satisfactory number of usable trees in 1 year. Diameter growth was directly proportional to growing space, but height growth varied little.

At the end of the second year, a maximum of 9 usable trees per linear foot of row were produced with a spacing of 15 trees per linear foot. Greater densities contributed nothing, and had the further disadvantage of increasing the cost of grading the stock.

Figure T-7.-Ponderosa pine seeds were collected from 80 stands from 1962 through 1964, and planted at the U.S. Forest Service's Bessey Nursery at Halsey, Nebraska, in 1965.

#### Ponderosa pine provenance study started on the Great Plains

Ponderosa pine seeds were collected from 80 natural stands, mainly east of the Continental Divide from Montana and North Dakota to New Mexico. Seedlings grown from the seed have been lifted, bundled, air freighted, and replanted for testing in North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Minnesota, Michigan, Missouri, New Mexico, Pennsylvania, and Saskatchewan and Alberta, Canada (fig. T-7). Many of the plantings were made by cooperators.

The provenances will be tested for adaptation to local environments, resistance to insects (especially tipmoth, <u>Rhyacionia</u> spp.) and diseases, and for suitability for use in wind barriers and other Plains plantings.

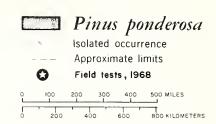
First-year survival was 80 to 97 percent.



In 1968, the 2+1 seedlings were dug,



counted, bundled, labeled, and placed in cold storage.



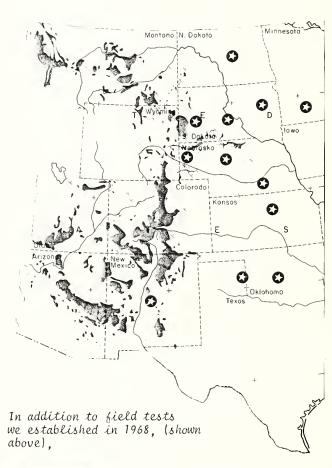




Figure T-8.--An introgressive series was demonstrated between the type approaching eastern redcedar, in eastern Missouri.



#### Junipers hybridize in the Missouri River Basin

Nearly 700 trees in 72 native stands of junipers were sampled throughout the Missouri River Basin to determine species composition and to clarify some of the interrelation between Rocky Mountain juniper and eastern redcedar. Analyses of 38 gross morphological, foliage, cone and seed, and biochemical characters demonstrated an introgressive hybrid series from southeast to northwest over the Basin, from the reported range of eastern redcedar into that of Rocky Mountain juniper (fig. T-8).

Quantitative differences in extractable lipids— as determined by infrared analysis of cone pulp extracts—yielded biochemical data useful as taxonomic characters. Consistent and significant correlation among these biochemical characters and the morphological characters suggested the desirability of infrared analysis of biological materials as a source of relationship evidence in taxonomic research.

through the Great Plains region, in central Nebraska.



into the type approaching Rocky Mountain juniper, in western Wyoming.



#### Forest Fire

## "Knowing the fuel" important for prescribed fires in chaparral

The inherent relationship between energy available in fuel to be burned and the thermal energy released by combustion was demonstrated by measurements of a series of 12 research fires in chaparral. Because energy output defines the effects that can be achieved with prescribed fire, this relationship will help in predicting how much fuel will burn for various combinations of weather and fuel conditions. Equations, charts, and slide rules are being developed for estimating how much fuel will burn at a particular time over a wide range of variables, such as fuel moisture, temperature, and humidity.

No difference in the input (fuel consumed)-output (heat released) relationship was apparent between manzanita and shrub live oak fuels. If verified by additional study, this finding will simplify estimating available fuel.

## Chaparral litter moisture content is rarely at equilibrium

Equilibrium moisture values for woody material accounted for less than 40 percent of the actual variation in moisture measured in chaparral oak litter samples taken January through June 1968. Even though the litter averaged only 1 inch in depth to mineral soil, the moisture content followed a long drying pattern after periods of precipitation.

Litter moisture content correlated best with the litter moisture factor used in the two-index system of measuring fire danger. <sup>2</sup> Litter moisture factor, based on precipitation, temperature, and days since precipitation, accounted for 66 percent of the variation in litter moisture. Other moisture indexes tested accounted for 37 to 42 percent of the actual variation.

## Fuel chemistry changes may affect flammability of chaparral

Laboratory tests point to an inverse correlation between flaming combustion and the ash content of the fuel—more ash, less flaming combustion. Less flaming combustion may hinder spread of fire. Natural leaf samples of chaparral contained considerably more ash in spring than in other seasons, with the least in winter. Chaparral may therefore tend to burn most rapidly in winter. Manzanita should burn more readily than oak, a relationship that fits well with burning experience.

Additional study, both in the laboratory and in the field, will be devoted to the effects of changes in fuel chemistry on actual combustion, how to estimate and predict chemical changes, and how to manipulate fuel chemistry to achieve special effects with prescribed fire.

## Fuel moisture in the national fire-danger rating system

Moisture response to different weather cycles was tested as a basis for dividing dead forest fuels into classes extending from the finest, which have a nearly immediate moisture response to changing ambient conditions, to the heavy fuels, which respond only to seasonal changes. Moisture response to the diurnal weather cycle was determined for 10 locations across the country by solving Fickian diffusion equations. After the effects of initial conditions were removed, the range, or nocturnal recovery, varied from an average of about 70 percent for fine fuels to less than 10 percent for larger fuels. A reasonable division appears to be a class of fine fuels represented by 1-hour timelag, and an intermediate class with from 2- to 20-hour timelag, perhaps represented by an 8- or 10-hour timelag. Fuels with longer than 20-hour timelag still need to be classified by their response to longer weather cycles.

The period of time required to remove the initial conditions in the computation may be considered the "buildup" period. This period was as small as 1 day for fine fuels and about 12 days for cylinders of 0.635 cm. radius.

<sup>&</sup>lt;sup>2</sup>Lindenmuth, A. W., Jr. Development of the 2-index system of rating forest fire danger. J. Forest. 59: 504-509, illus. 1961.

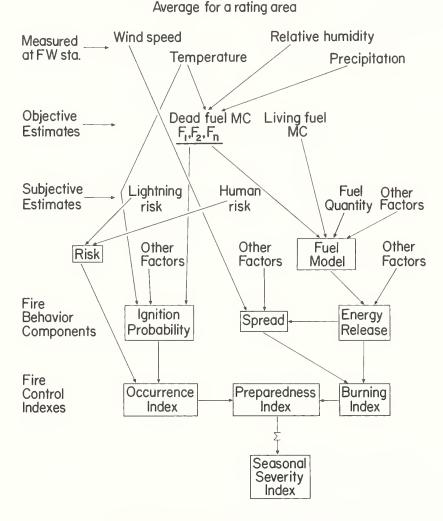
## National fire-danger rating project begun

The national fire-danger rating project aims to provide three fire-control indexes: fire occurrence index, a burning (dispatching) index, and a preparedness index (fig. F-1). The first will be a number related to the probable number of fires in a reasonably uniform rating area. The second and third will be numbers related to the potential fire suppression

jobs for (a) an average fire in the rating area, and (b) a day in the rating area, respectively. An administrative tool—a seasonal severity index—will also be provided. This will be an accumulation of the daily preparedness indexes, and will summarize the potential fire-control job for the period from the beginning of the season to date.

These indexes will be based upon the components of fire behavior, which in turn will be derived from the measured and estimated factors in figure F-1.

## MEASURED FIRE DANGER



#### NATIONAL FIRE DANGER RATING

Figure F-1.--Fire control indexes will be based on the components of fire behavior, which in turn will be derived from measurements and subjective and objective estimates.

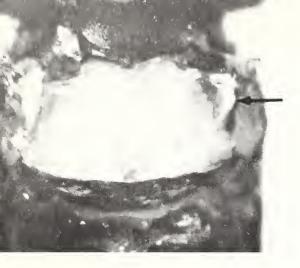


Figure I-1.-The flight
muscle of the
mountain pine
beetle develops
from a stringy
fiber (left)
to a welldefined muscle
(right) just
prior to
emergence.



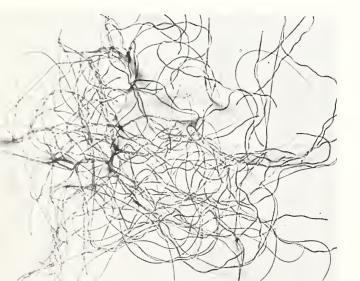
#### **Forest Insects**

Muscle development in mountain pine beetles may signal emergence

Flight muscles of mountainpine beetles (<u>Dendroctonus ponderosae</u> Hopkins) begin to enlarge well before any beetles emerge. This development is most easily seen in the thickness of the muscle (fig. 1-1). By the time beetles start to emerge, mean muscle development in the population beneath the bark is about half of its final size. Study is continuing to determine whether the relationship between muscle enlargement and various stages of emergence is constant. If so, this knowledge will significantly improve the efficiency of beetle attraction tests and use.

Incidence of sperm in emerging female mountain pine beetles

Mountain pine beetles (<u>Dendroctonus ponderosae</u> Hopkins) are attracted to specific trees by forcing



female beetles to attack the designated trees. Unmated females are known to produce the attractant. Beetles used in attractant tests have been assumed to be unmated when collected during the brood emergence period.

Recently, three separate broods from field-infested trees were examined for sperm (fig. I-2). Samples of emerging females showed sperm in 13, 19, and 17 percent of the total female production. In subsequent laboratory tests where reemerging parent females were captured, less than 1 percent of the brood females contained sperm. Such data strongly suggests that the emerging brood contains many female parents.

The dispersal and attack habits of the mated female parents now need investigation to determine their role in attraction.

## Insect predator of the mountain pine beetle

The fly, <u>Medetera aldrichii</u> Wh., preys on the mountain pine beetle, <u>Dendroctonus ponderosae</u> Hopkins. The larvae of the fly feed on the egg and larval stages of the beetle, and are largely responsible for the reduction in beetle populations during the overwintering period. The adult female lays her eggs in minute depressions in the bark of

Figure I-2.--Sperm cells of the mountain pine beetle.
Length is approximately 0.125 mm.

beetle-infested ponderosa pines (fig. 1-3). The location of the eggs is particularly important, because the larvae which hatch must move across the exposed bark to the entrance hole of the beetle gallery. Mortality during this larval movement reduces the effectiveness of the fly. This phenomenon plus other ecological relationships are being evaluated with respect to the potential of <u>M. aldrichii</u> as a biological control agent.

#### Biological evaluation of western budworm refined by egg count and percent defoliation

Population trends of the western budworm (<u>Choristoneura occidentalis</u> Freeman) are followed from year to year by means of egg-mass surveys. Counts of new egg masses are adequate to show trends unless the numbers of eggs per mass vary considerably from year to year.

From 1959 through 1965, egg-mass sizes fluctuated widely in budworm infestations in Colorado. Averaged throughout the Region, the number of eggs per mass declined to 23.6 when egg-mass densities were high, and rose to 31.9 when egg-mass densities were low. When budworm larvae are numerous, food is in short supply and the moths are small and lay small egg masses. The relationship between the number of eggs in a mass (Y) and its length (X) is linear (Y = a + b X) for masses of 1, 2, 3, or 4 rows (table l-1).

The numbers of eggs in egg masses can now be determined by measuring lengths of masses with a calibrated micrometer eye piece in a binocular

Table I-1.--Means and regression statistics from analyses of relationship of eqq mass size and eqq numbers in unhatched masses on needles from Douglas-fir and white fir

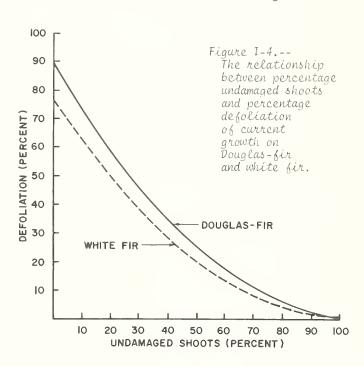
Number of egg rows, and species	Mean egg mass length	Mean number of eggs	a	þ	
	mm.				
One row: Douglas-fir White fir	2.32	2.88 3.42	-0.78 -0.24	1.58 1.58	
Two rows: Either species	6.02	18.58	-4.26	3.79	
Three rows: Either species	7.49	32.82	-3.01	4.78	
Four rows: Douglas-fir	8.31	46.72	+0.24	5.59	



microscope, and referring to a conversion table, prepared from table 1-1.

Assessment of defoliation is an essential part of biological evaluation of a western budworm infestation. It helps managers determine the need for suppression. The percentage defoliation of current growth was found to be related to the percentage of undamaged shoots (fig. 1-4).

In application, the estimate of defoliation is obtained from a sample of foliage collected for counts of egg masses. One hundred new shoots, taken at random from the entire collection of foliage from the plot, is classified as "damaged" or "undamaged" by feeding of budworm larvae. An estimate of defoliation is then read from figure I-4.



Two species of weevils free of parasite nematodes

Not a single individual among many hundreds of white pine weevils, Pissodes strobi and P. approximatus, were found to be parasitized by nematodes. The weevils were collected in New York, Connecticut, and Maine. Many associated nematodes were taken, however, from weevil galleries and may eventually develop parasitic habits. Because weevil habits are similar to bark beetle habits, it may be possible to transfer bark beetle nematode parasites to tree-infesting weevils for control purposes.

#### **Forest Diseases**

Lodgepole pine dwarf mistletoe common on ponderosa pine in central Rockies

Studies in many parts of the West suggest that parasitism of ponderosa pine by the lodgepole pine dwarf mistletoe, <u>Arceuthobium americanum</u>, is more common than previously thought. <u>P. ponderosa var. scopulorum</u> in Colorado, Utah, and Wyoming is very susceptible, whereas <u>P. ponderosa var. ponderosa</u> in California, Idaho, Oregon, and Washington is only occasionally infected.

Lodgepole pine dwarf mistletoe is unusually common on ponderosa pine in the Roosevelt National Forest in northern Colorado (fig. D-1). This crossover occurs most frequently outside the range of the ponderosa pine dwarf mistletoe, A. vaginatum subsp. cryptopodum (Engelm.) Hawks. & Wiens, but rarely within it. This suggests that if one species of dwarf mistletoe is present on a tree species, it

tends to exclude other species from the host. The reasons for this exclusion are being investigated.

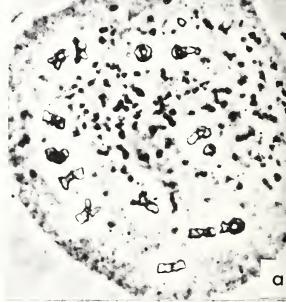
Chromosomal and flowering characteristics useful in taxonomic revision of Arceuthobium

Chromosome numbers and other karyological features of <u>Arceuthobium</u> have been studied for all species and subspecific groups in the United States, and 7 of the 13 entities in Mexico. The only chromosome number known in the genus is n = 14, and the karyotype appears to be fundamentally symmetrical (fig. D-2). The existence of strong isolating mechanisms, which apparently preclude natural hybridization, may explain the absence of polyploidy in the dwarf mistletoes. The flowering characteristics of the American species have been analyzed and classified into three groups. In the first type (<u>A. vaginatum</u>), flowering occurs in the spring immediately preceded by meiosis; in the second type

Figure D-2. -- Chromosomes in Arceuthobium.

a. Early meiotic metaphase in  $\underline{A}$ .  $\underline{gillii}$  subsp.  $\underline{gillii}$  (n = 14).

Mitotic metaphase in the apex of a developing embryo in A. campylopodum f. cyanocarpum (2n = 28). Both about x 900.



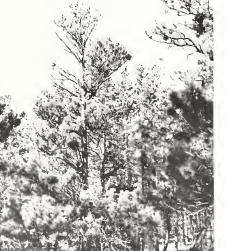
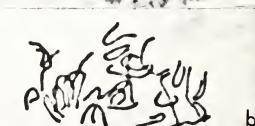


Figure D-1.-A pure ponderosa pine
stand infested by
the lodgepole pine
dwarf mistletoe,
Arceuthobium americanum.
Roosevelt National
Forest, Colorado.



(<u>A. campylopodum</u>), flowering occurs in the summer or fall but again is immediately preceded by meiosis; in the third type (<u>A. americanum</u>), flowering occurs in the spring, but meiosis takes place the preceding fall. These flowering groups are closely correlated with several morphological characteristics, so they seem to represent a natural basis for structuring a below-genus classification of <u>Arceuthobium</u>—an essential aspect of our taxonomic revision of the dwarf mistletoes.

# Both sodium and chloride implicated in foliage disease of ponderosa pines in Denver

Cooperative studies with Colorado State University have established a direct relationship between sodium and chloride content of needle tissue, and severity of disease. The disease, so far found only in the Denver area, has been experimentally produced in potted seedlings irrigated with solutions of various salts.

Exposure of grafted clones of affected and unaffected pines to experimental treatments have failed to establish any differences in susceptibility (fig. D-3). Trees unaffected in nature appear therefore to have simply escaped damage due to salts.

Concentrations of air pollutants detected by analytical and plant-indicator techniques appear insufficient to be causally related. Artificial fumigations have failed to produce symptoms typical of the disease.

# Seed-protectant chemicals can reduce germination

Chemicals bound to seeds with latex or methyl cellulose have protected them from damping-off fungi, birds, and rodents in some nurseries. However, treated seeds sometimes produce poor seedling stands. Tests were made to determine if poor stands might be due in part to toxicity of the chemicals used. Ponderosa pine seeds were coated with commonly used seed protectants (Arasan-75, Captan, Maneb, Zineb) at the rate of 1, 2, or 3 ounces per pound of seed, and germinated in sterile sand. There were marked decreases in rate of germination and total germination of seeds treated with high rates of the chemicals, moderate decreases with medium rates, and little or no decreases with low rates.

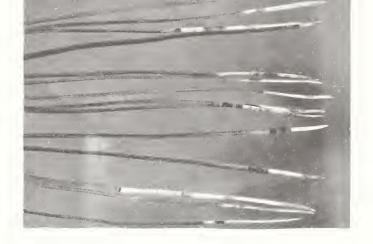


Figure D-3.--Ponderosa pine needles showing typical resin infiltrated bands and tipburn that are associated with high sodium and chloride content.

# Nematodes recovered from aspen cankers

One new genus and four new species of nematodes were recovered from Cenangium and Ceratocystis cankers of aspen. The nematodes, all insect associates, were taken from the necrotic tissue of the bark and phloem. In addition, several previously described species were collected: Acrostichus concolor, Plectonchus wyganti, and Panagromacra margaretae. Several species of the genera Aphelenchoides, Panagrolaimus, and Panagrobelus were also taken from the cankers. The nematodes were evidently carried to the cankers by insects belonging to the genus Epurea. It is thought that the nematodes may play an important role in the spread of the cankers.

### Ponderosa pine seedlings benefit from soil fumigants

Root-lesion nematodes (<u>Pratylenchus penetrans</u> (Cobb) Sher & Allen) have damaged seedlings of ponderosa and Austrian pines in a central Nebraska nursery. In infested areas, beds fumigated with methyl bromide produced more and larger ponderosa pine seedlings than untreated beds. In areas not infested with nematodes, seedlings were as large in nonfumigated beds as in beds fumigated with methyl bromide, Brozone, Trizone, or Telone-PBC. A test with methyl bromide and sulfuric acid, alone and in combination, indicated no need for sulfuric acid for damping-off control on beds previously fumigated with methyl bromide.



# Range Management

Sherman big bluegrass good for range seeding in ponderosa pine zone

Sherman big bluegrass has been successfully established consistently at the Manitou Experimental Forest, Colorado, by planting into a moist seedbed during the normally wet months of July and August. Establishment was highest when seed was planted to a 5/8-inch depth with a double-disc, depth band drill. Establishment of satisfactory stands has been sporadic by methods previously used.

A 90-acre seeding established on abandoned fields had an average of 24 seedlings per linear foot of drill row by October of the same year. Survival through the winter was excellent and, by the following August, big bluegrass yield averaged 2,608 pounds per acre. Yields in the second year averaged 4,193 pounds, and ranged from 3,023 pounds per acre on the lowest producing part, to 5,408 pounds per acre on the highest producing (fig. R-1). With these kinds of yields, Sherman big bluegrass appears promising for providing high livestock production on a minimum range acreage.



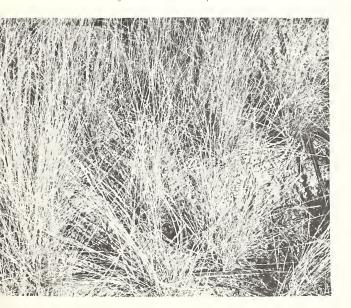
Figure R-1.--A 5-acre pasture of Sherman big bluegrass planted July 20, 1965, on the Manitou Experimental Forest, Colorado. On this 5 acres, seedlings averaged 28 per feet of row in October 1965. Vields averaged 2,638 pounds per acre in 1966 and 4,333 pounds per acre in the fall of 1967.

# Four-inch stubble height found best for Sherman big bluegrass ranges

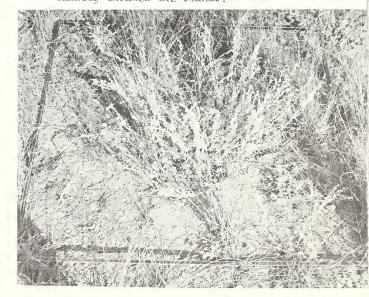
Grazing Sherman big bluegrass to a 4-inch stubble height was better for the grass stands than either lighter grazing to a 6-inch stubble or heavier grazing to a 2-inch stubble (fig. R-2) when grazing was conducted throughout the growing season. After

Figure R-2.--Microplots on Sherman big bluegrass range grazed for 7 years.

Area grazed to 4-irch stubble retained good forage production and ground cover, with minor invasion by undesirable plants.



Area grazed to a 6-inch stubble was depleted in spots, and fringed sagebrush (large plant center) and other undesirable plants readily invaded the stands.



7 years, forage production from the 4-inch treatment (1,400 pounds per acre) averaged 32 pounds per acre more than from the 6-inch stubble height treatment, and 258 pounds more than from the 2-inch treatment.

Plant densities showed a similar trend in favor of 4-inch grazing: the density of Sherman big bluegrass averaged 2.26 plants per square foot in the areas grazed to 4 inches, but only 1.47 and 2.04 in the 2- and 6-inch stubble height treatments. The number of invading species per square foot was correspondingly fewer in the 4-inch treatment. The lighter use resulted in large areas of coarse "wolf plants" that were grazed little throughout the study. This caused concentrated grazing in small spots, which became depleted. The whole grass stand was depleted when grazed to a 2-inch stubble height.

In addition to maintaining good grass stands, beef gains from the 4-inch stubble height treatment averaged 78 pounds per acre. This beef gain was larger than for any other seeded or native species tested previously at the Manitou Experimental Forest, Colorado.

### Integrate use of seeded and native ranges to increase efficiency of range grazing

Grazing seeded and native range on an integrated basis extends the grazing season on green forage, permits more flexibility in season of stocking, removes grazing pressure from spring and fall bunchgrass ranges, and materially increases livestock production.

After 6 years and five calf crops in a study at the Manitou Experimental Forest and Range, Colorado, weaning weight per calf has averaged 31 pounds more than from native ranges, with an added value of \$8.33 per calf by incorporating seeded ranges into the management system.

Most of the difference in weaning weights between the two systems came while the animals on the combination of range types were grazing Sherman big bluegrass ranges in the fall, and the others were on native fall range. Calf weights on October 15 averaged 411 and 400 pounds for the two herds. Following 30 days of grazing with their mothers on big bluegrass, calves averaged 453 pounds compared with 422 pounds for calves grazing native range.

# Study of unherded sheep being tried on alpine range

In a cooperative study with the University of Wyoming, one band of Columbia sheep were unherded on an alpine allotment, while a herder stayed with another band. Both bands behaved in much the same manner. The unherded band remained in a single group or on rare occasions, split into two or three groups for short periods. The unherded sheep apparently were conditioned by herding during the remaining 10 months of the year.

The unherded sheep grazed the allotment more uniformly than the herded band. In 1966 steepness of slope, elevation, and distance to water did not influence the degree of use of major forage species. In 1967 utilization tended to decrease as steepness of slope and elevation increased. But these relationships, although statistically significant, were not pronounced. Lambs gained equally well in both bands.

# Control of golden avens results in loss of desirable forbs

Spraying golden or alpine avens with 2,4-D resulted in the loss of many desirable broad-leaved forage species on an alpine sheep range in Wyoming. Seven of the 13 forbs studied in the vegetation were essentially eliminated; the remaining 6 were unaffected.

One year after spraying, the loss of forb production was only partially compensated for by greater production of grasses. Of the grass and grasslike species, only timberline bluegrass produced more herbage as a result of spraying. Consequently, total herbage production on the sprayed areas was only 77 percent of that on adjacent areas.

The yield of digestible dry matter was reduced by one-third on the sprayed area. The reduction was a function of two factors—lower total herbage production and a lower average digestion coefficient. Many of the highly digestible forbs were eliminated by the spraying, and their loss was only partially compensated for by greater production of herbage by timberline bluegrass—a species of relatively low digestibility.

# Life of a sagebrush control program

The initial benefits of controlling big sagebrush by spraying with 2,4-D and 2,4,5-T on a grazed range in central Wyoming began to decrease within 5 years after spraying; within 14 years the sagebrush essentially had become reestablished. Seventeen years after spraying the sagebrush stands were denser than before. On areas not grazed, some deterioration of initial benefits had occurred within 17 years—young sagebrush plants were more abundant on sprayed than unsprayed areas, but mature plants were only 50 percent as abundant and crown cover was less.

The studies were made at Beaver Rim (6,800 feet elevation) 36 miles southeast of Lander, Wyoming, where annual rainfall is estimated to be 7-9 inches.

Individual range plants can be identified from large-scale color infrared aerial photographs

Individual plants can be detected and identified on large-scale (1:650 - 1:900) color infrared aerial photographs when photos are taken at the right time during the growing season (figs. R-3, R-4).

In late July, for example, bitterbrush appeared bright red while big sagebrush appeared light pink. Both species were a similar shade of green on regular color photographs exposed at the same time. Growth stage of the plants is important; the species were difficult to differentiate with either film type in the early leaf-growth stage in early June. In contrast, shorthair sedge was difficult to detect in July photographs when the species was mature and dry, but appeared bright pink in June on color infrared photographs. Late August photographs provided the best opportunity for species differentiation in the color infrared photographs on high-elevation (10,000 feet) grasslands.

This research on aerial photographic techniques, in cooperation with the National Aeronautics and Space Administration, is being conducted to develop new range inventory and vegetation surveillance procedures.



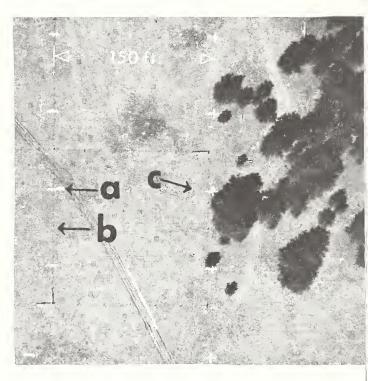


Figure R-4.--Black and white photo made from 1:2400 scale 70 mm, color aerial transparency.

(a) dash-type flight-line marker,

(b) 3-foot lath cross,

(c) group of range feature arrows on a 20-foot vegetation transect...note paper plate immediately above group.

Special storage temperatures not necessary for fourwing saltbush seed

Special storage conditions apparently are not necessary for seeds of fourwing saltbush. Seeds from four sources were stored 4 years under refrigeration at 38° to 42°F. Percent germination of these seeds was no higher than for seeds from the same lots stored at 55° to 95°F. Viability of seeds stored under dry conditions at 55° to 95°F. was still high after 6 years.

# Germination temperatures for fourwing saltbush

Fourwing saltbush germinates best between 55° and 75°F. Germination exceeded 90 percent over a fairly wide temperature range, but seeds germinated appreciably less at temperatures from 39° to 55°F. and from 75° to 100°F. Germination under alternating temperatures generally averaged less than at the corresponding constant temperatures. The results suggest that germination conditions for fourwing saltbush are likely to be optimum during the cooler periods of the year in the Southwest.

### Regression sampling a low-cost way of strengthening range resource inventory data

Data on total herbage production, total perennial grass production, and total forage consumed, needed for evaluations of range and watershed treatments, are expensive to obtain. Work on the Beaver Creek Watershed Evaluation Project in northern Arizona has demonstrated that valuable improvements in precision of statistical estimates can be gained by using a regression sampling procedure with auxiliary information about the timber overstory.

Relative precision of estimates made from a sample of herbaceous understory often can be doubled at little cost. Percent crown cover, determined from aerial photos, is the most useful auxiliary variable because it is low cost and easy to obtain. Basal area of timber and depth of pine needle litter also can be used, but these data are harder and more expensive to obtain.

### Cattle prefer Arizona fescue early and mountain muhly late during summer grazing season

On ponderosa pine summer range in northern Arizona, the proportion of Arizona fescue in the cattle diet decreased as the summer progressed. while mountain muhly increased, although summerlong diet proportions of these two species were similar. The seasonal differences in diet proportions are related to the early growth of Arizona fescue and the later growth of mountain muhly. Animals apparently prefer each species during its period of rapid growth. Bottlebrush squirreltail and sedges were high in the diet throughout the summer, even though their contribution to total herbage production was relatively low. Conversely, cattle preferred forbs less than grasses throughout the season, although forbs made up 42 percent of the available forage. Forb consumption was only 6 to 14 percent of the cattle diet.

# Grass plant parts differ in digestibility value

Of four grasses studied on ponderosa pine range in northern Arizona—Arizona fescue, mountain muhly, bottlebrush squirreltail, and foxtail barley—leaves were more digestible, on the average, than stems and heads in August, and heads were more digestible in September. Since cattle are selective grazers, the stage of plant development and differences in nutritive value of plant parts will probably influence animal preference and intake of a particular forage species.

### Cool-season grasses and shrubs are nutritious forage on chaparral winter range

In the Arizona chaparral, the cool-season grasses—longtongue mutton bluegrass and bottle-brush squirreltail—supply forage of higher nutritive value during winter than do the warm-season gramas. Comparatively, shrubs—hairy cercocarpus, desert ceanothus, and shrub live oak—have good nutritive value during winter; leaves produce more nutrients than stems. These nutritive values indicate shrubs could supply good forage for wintering livestock if consumed.

# Rotating use of watering places can improve forage production

Closing watering places seasonally reduced average utilization of perennial grasses near them on semidesert range on the Santa Rita Experimental Range in southern Arizona. Use of five watering places in a 3,000-acre pasture was rotated to provide rest at each watering place two summers out of three. Utilization in the pasture was compared with that in an adjacent pasture where the water was left open yearlong. Utilization of perennial grasses near a given water was reduced substantially in years when the average use of perennial grasses in the pasture did not exceed 45 percent, and when the closed period included the summer growing Utilization differences within 500 yards of water were not strongly related to distance from water. Little was gained by closing one of two waters that were close together, as in a small pasture, nor did closing water help if the entire range was closely grazed.

Yield and cover of perennial grasses near seasonally rotated water averaged two to three times higher than around water open yearlong. The greatest benefits were obtained in years when summer closing of water was accompanied by high forage production and relatively low utilization for the pasture as a whole. The method offers most promise for large range units with permanent watering places far apart.

January 1961, before cabling



# Increases in cholla cactus after cabling may be temporary

Numbers of jumping cholla and other cholla increased greatly on the Santa Rita Experimental Range, near Tucson, Arizona, during the first year after cabling, but declined to pretreatment levels after 3 years. All cactus species, however, both on cabled and uncabled areas, declined in number between the third and seventh years after the cabling was done (fig. R-5). Final cactus densities on cabled and untreated areas were about the same.

Cholla cactus stands in Arizona commonly build up to peak density and vigor, then decline almost to extinction as the mature plants become senescent, and plants of all ages die. The cholla stand in this study apparently was declining when the study started, and (except for a temporary increase in plant numbers) cabling merely hastened the decline. Cabling vigorous, young cholla stands could produce more lasting increases in cactus. All of the great number of young plants observed 1 year after cabling originated vegetatively from stem segments or fruits.

The study was conducted cooperatively with the U. S. D. A. Agricultural Research Service.

Figure R-5.--Stand of jumping cholla.

January 1966, after cabling



### Wildlife Habitat

Stock ponds containing abundant emergent and shore vegetation important to puddle ducks

Puddle ducks make good use of those large, shallow stock ponds on the National Grasslands of western South Dakota that contain abundant emergent vegetation, primarily rushes and cattails, and good shore vegetation of tall grasses, sweetclover, or other forbs. Over twice as many young puddle ducks were raised in ponds with an abundance of

Figure WH-1.--Blue-winged teal brood on stock pond with abundant emergent vegetation.

Amount of shore vegetation, however, may be more important for duckling survival.

shore vegetation (fig. WH-1) as in ponds with sparse shore vegetation.

Thirty-nine species of waterfowl and shore birds were observed on 12 study ponds during the ice-free periods in 1966 and 1967. The ponds supported an average of 7 birds per pond per day for 214 days in 1966, and 13 birds for 229 days during 1967.

This indication of the importance of stock ponds was developed from the first phase of a study of the relationship of fencing stock ponds to quality of waterfowl and upland bird habitat provided. The tens of thousands of stock ponds in the western parts of North and South Dakota could partially offset the loss of waterfowl habitat resulting from the drainage of the wetlands, or pothole lands, in the Dakotas, Minnesota, and the Canadian prairies.





Figure WH-2.--Key winter deer range on the McVey Burn.
Important browse plants are subject to intense browsing by white-tailed deer, and competition from grasses, forbs, and ponderosa pine.

# Bearberry is important winter food of white-tailed deer

During the critical period of winter stress, bearberry (kinnikinnick) was the predominant species used by white-tailed deer in the Black Hills Experimental Forest in South Dakota. Here, forests are predominantly ponderosa pine with a relatively sparse understory that includes a variety of shrubs, forbs, and grasses (fig. WH-3). Forage and browse species ranked from high to low in order of importance in the diet during the January-to-April period were as follows:

- 1. Bearberry
- 2. Wheatgrasses
- 3. Ricegrasses
- 4. Forbs (other than those listed)
- 5. Clovers
- 6. Common juniper
- 7. Bluegrasses
- 8. Low Oregongrape
- 9. Serviceberry
- 10. Shinyleaf spirea
- 11. Common snowberry

This tentative ranking was based on examination of rumen contents of deer collected in cooperation with the South Dakota Department of Game, Fish, and Parks.

Figure WH-3.--White-tailed deer in ponderosa pine forests on the Black Hills Experimental Forest, western South Dakota, fed on a wide variety of plants during winter.

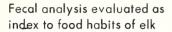
### Siberian peashrub highly preferred by deer in the Black Hills

White-tailed deer browsed Siberian peashrub (caragana) more intensively than other planted shrubs, on both small row plantings and a 5-acre pilot test planting on the McVey Burn in the Black Hills of South Dakota. Chokecherry, serviceberry, and Russian-olive were grazed moderately on the row plantings. On the 5-acre pilot test on the heavily used winter range, the peashrub, chokecherry, and American plum all received high deer use, with use of peashrub the heaviest.

The heavy deer use in the pilot test indicates shrub revegetation programs to rehabilitate heavily used deer habitat such as on the McVey Burn winter range may be very difficult unless the transplanted shrubs can be protected. These studies are part of a program of the investigations to determine deer range improvement practices for key habitat in the Black Hills (fig. WH-2).







Amounts of grass and forb material in the feces of elk were found to compare very closely with composition of plant material consumed. These results were obtained from feeding trials conducted with penned elk, in cooperation with the Wyoming Game and Fish Commission.

A half-acre plot on the Snowy Range of southern Wyoming was mowed in August 1968. Two penned elk at the Sybille Wildlife Research Unit were fed the freshly mowed meadow vegetation exclusively for 10 days. They are an average of 26 pounds of dry forage each day.

Examination of fecal pellets (fig. WH-4) collected 5 days after the first feeding indicated that the forage utilized was 94.4 percent grass and 5.6 percent forbs. Actual dry weight in the vegetation fed to the elk was 94.7 percent grass and 5.3 percent forbs.

More testing of vegetation composition at other periods of the year and with other kinds of forage will be conducted to further evaluate the method.

### Small strips cut in forest are used better by deer than large cut blocks

On summer range in central Colorado, mule deer used small experimental clearcut strips (1 to 6 acres in size) in spruce-fir and lodgepole pine forests three times as heavily as adjacent uncut forest 10 to 11 years after cutting. Strips were used less than adjacent forest for the first year or two. No increase in deer use was found on large operational clearcuts.



# Mistletoes are highly digestible by deer

Mistletoes (<u>Arceuthobium</u> and <u>Phoradendron</u> spp.) in Arizona have been found to be highly digestible by deer in in vitro digestion trails. The high digestibility apparently is related to low yearlong crude fiber content. Mistletoes are high in energy, with intermediate levels of most other nutrients.

Although feeding trials have demonstrated strong deer preference for mistletoes, use of available material by wild deer is usually light.

# Important deer forages in the chaparral evaluated

Average digestibilities of major constituents of deer diets in chaparral at the Three Bar research area in central Arizona were found to be: browse 35 percent, forbs 55 percent, fruits 48 percent, and grass (early growth of foxtail chess or red brome only) 58 percent. Deer apparently did not select forages of higher digestibility among species abundantly available. Scarce forages requiring considerable effort to obtain significant amounts were invariably more highly digestible.

The same forage species were chemically analyzed during the critical dry fall period. Protein was adequate in most species, with none below the minimum 7 percent; several were at or above the optimal 13 percent. Although phosphorus content of most available forages was somewhat below the minimum 0.25 percent, a few abundant species, eaten in quantity, contained more than 0.25 percent. Deer selectivity for plants high in phosphorus was slight.



Deer feeding habits studied with tame deer

Factors that determine the quality of both summer and winter range are being studied with trained, tame mule deer (fig. WH-5). Use of tame deer permits closeup observations of forage choices in relation to availability in a variety of situations, which in turn permits better evaluation of range quality, and more discriminating tests of the nutritional values of forage plants. We are cooperating with the Colorado Division of Game, Fish, and Parks and Colorado State University to develop a herd of tame deer for wildlife habitat studies under controlled conditions.

### Gambel oak sprouts can furnish much-needed browse in ponderosa pine habitat

Ponderosa pine habitats of the Southwest, often deficient in browse for deer and elk, can be improved by encouraging existing Gambel oaks to sprout.

On one watershed of the Beaver Creek Watershed Evaluation Project in northern Arizona, most Gambel oaks treated with ammate were top killed, but stumps often sprouted profusely (fig. WH-6). Because sprouting capacity decreased in trees of the large diameter classes, trees less than 12 inches d.b.h. should be favored where sprouts are to be encouraged for browse production.

Figure WH-6.--Smaller Gambel oaks sprout profusely after top-kill. The sprouts are valuable sources of browse for deer and elk in ponderosa pine habitat.

### Figure WH-5 .--

We can study forage and browse preferences of deer very closely with tame, trained animals. The scientist collects a bite-sized sample of each plant the deer selects for later identification, and simultaneously dictates observations into a tape recorder hung around his neck.

# Timber harvesting beneficial to wildlife

Harvesting the ponderosa pine forest creates a diverse habitat for deer and elk. Deer and elk use, as measured by pellet groups and sight observations, increased the first year after logging one of the Castle Creek experimental watersheds on the Apache National Forest, Arizona. Area of deer concentration within the watershed increased from 78 acres before logging to 168 acres after. No evidence of elk use was observed in the watershed prior to timber harvesting, but was found on 48 acres the year after logging. The increase in acreages used reflects a change in food production either from downed slash or new growth caused from opening the forest canopy.



# **Forest Biology**

(In cooperation with the Fish and Wildlife Service, U. S. Department of the Interior)

Deer mouse populations similar on grazed and ungrazed salt-desert range

The deer mouse has been the most common small mammal inhabiting the experimental watersheds at Badger Wash Experimental Area in western Colorado. Other small mammals present, but with smaller populations, include the piñon mouse, Apache pocket mouse, western harvest mouse, northern grasshopper mouse, desert wood rat, Ord's kangaroo rat, white-tailed ground squirrel, white-tailed prairie dog, desert cottontail, and black-tailed jackrabbit.

The estimated population of deer mice in May 1968 was about four mice per acre on both grazed and ungrazed watersheds. Annual populations fluctuated over the years, but remained similar for grazed and ungrazed salt-desert ranges.

# Pocket gopher population peaks 9 years apart

The northern pocket gopher population on grazed ranges at Black Mesa Experimental Range in western Colorado was about 30 animals per acre in the fall of 1968. The previous high, about 28 pocket gophers per acre, occurred in the fall of 1958. The high population in 1958 was largely the result of good survival of pocket gophers from the preceding year; animals 1 year of age or older made up about 60 percent of the fall population. The 1968 high was attributable to young produced during the current year; young-of-the-year gophers made up about 70 percent of the fall population.

The pocket gopher (fig. FB-1) is being studied at Black Mesa to learn if the size of the population is affected by three intensities of grazing imposed on Thurber fescue-forb range by cattle in summer and fall. Other aspects of the study include learning what influence these burrowing, herbivorous animals have on forage production, plant species composition, and plant ground cover.

Figure FB-1.--The fossorial pocket gopher is the most abundant rodent on grazed ranges at Black Mesa.



# Clumps of trees are best turkey roost sites

All but one of 12 turkey roost sites in central Arizona contained a group of trees, and 10 were located within 1/2 mile of permanent water. Measurements were taken on 158 used and 42 unused ponderosa pine trees at the 12 sites to determine the preferences of Merriam's wild turkey for certain site and tree characteristics for roosting. The measurements included height, d.b.h., distance from ground to first branch, and age of the tree, together with slope, aspect, and distance from permanent water. The number of trees in each site used for roosting ranged from 1 to 37, and averaged 13. Results indicate a preference for easterly exposures and tall, mature, open-branched trees without branches near the ground (fig. FB-2). On the basis of this information, it is suggested that forest managers consider leaving clumps of trees with these characteristics interspersed throughout the turkey range where logging programs are planned.

# Oak and cercocarpus most important in deer diet at Fort Bayard

Analyses of rumen contents taken from 59 mule deer on the Fort Bayard study area in southwestern New Mexico showed oak and cercocarpus were the most important items in all seasons. As would be expected, utilization of forbs increased during summer and fall months. Although 42 plant species were represented in the rumens, at least 80 percent of the total diet during all seasons was comprised of the following nine: cercocarpus, dalea, tansymustard, James bundleflower, Wright silktassel, juniper, mistletoe, oak, and skunkbush sumac.

These results were obtained from mule deer taken during hunting seasons and from collections made for other purposes over the period 1964-68 as part of a cooperative study by the U. S. Bureau of Sport Fisheries and Wildlife, U. S. Forest Service, and New Mexico Game and Fish Department.

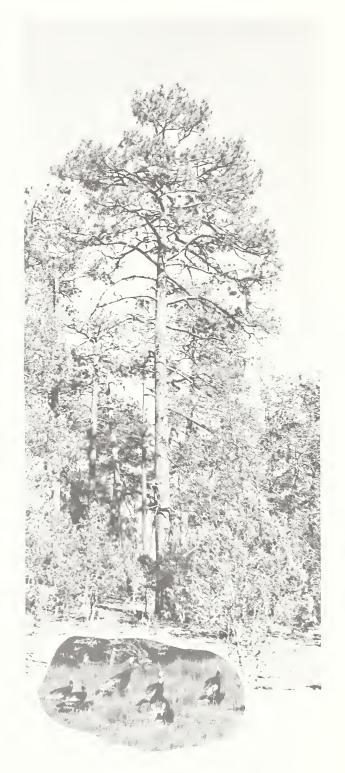


Figure FB-2.--Heavily used turkey roost tree on the Apache
Indian Reservation, Arizona.

# Forest Economics, Utilization, and Marketing Research



### **Forest Economics**

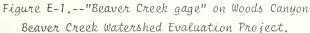
New Beaver Creek streamgage design adopted for use at other locations

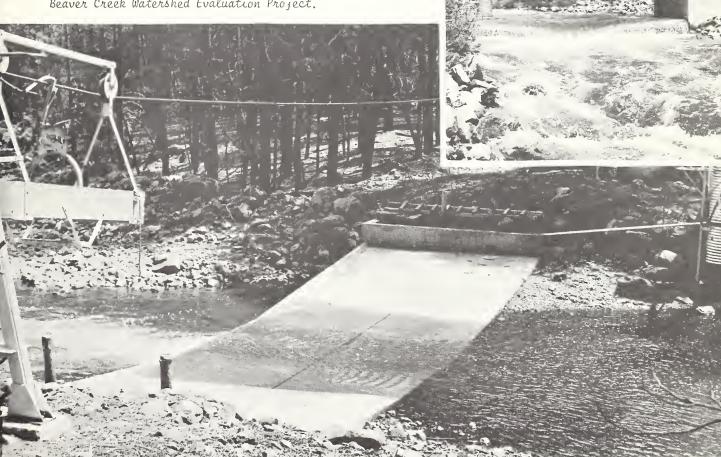
Measuring the discharge of large mountain streams is becoming increasingly important to forest watershed managers. The Beaver Creek Watershed Evaluation Project in Arizona needed a stream gage designed to permit precise measurement of discharges ranging from 1 to 1,000 cubic feet per second or more, in a structure that could be field rated and that would pass large amounts of sediment and debris. Such a design was developed by project scientists (fig. E-1). It consists of a combined

control and measuring section with 1:5 lateral slope at the center and 1:10 slope at the sides. A 6-inch lip at the downstream edge acts as a weir and impounds enough water to permit current metering at low stages.

The design has proven successful and is being adopted by others. Gages have been constructed or are planned at several locations in Colorado, Utah, and Arizona (fig. E-2). Field ratings of four gages on the Lake Creek Barometer watershed, San Isabel National Forest in central Colorado, show a consistent stage-discharge relationship generally similar to the original Beaver Creek gages.

Figure E-2.--The "Beaver Creek gage" in operation at North Fork, the Lake Creek Barometer watershed, June 1968.





# Killing juniper has not increased water yield in Arizona

Two pilot tests on the Beaver Creek Watershed Evaluation Project in northern Arizona have failed to show any real change in either streamflow or sediment yield after juniper was killed. In the first test, Utah juniper was uprooted by pulling a cable between two heavy tractors. Total herbage production increased, but there has been no significant change in perennial grass production or apparent deer use. Pits created when trees were uprooted may have caused some retention and evaporation of water that otherwise might have gone into the stream.

In the second test, alligator juniper trees were felled with saws to avoid pitting. Although herbage production nearly doubled the second year—from 490 to 920 pounds per acre annually—it subsequently decreased, and streamflow and sediment still showed no real change. Cabling is a common range improvement practice, and it has been commonly thought that it also might improve water yields.

# Cost analysis can lead to cost reduction

Analysis of data on how the job was done and costs of doing it showed that felling alligator juniper trees could be done for considerably less money. On a pilot watershed, it cost \$34 per acre to cut the trees with chain saws, pile the slash, and treat juniper and oak stumps with sprout-preventing chemicals. Analysis showed that costs can be expected to vary by as much as 30 percent. Felling very large trees and treating stumps with chemicals caused most of the variation. Planning and management, focused on these two jobs, can lower costs. Cost analysis is an important part of economic studies, and it is a technique that can be useful to forest resource managers.

### Figure U-1 .--

Fiber overlays are glued to low-grade lumber in a continuous, high-speed process (top). Close-up of roller system (bottom) that wraps overlay around edges of the board.

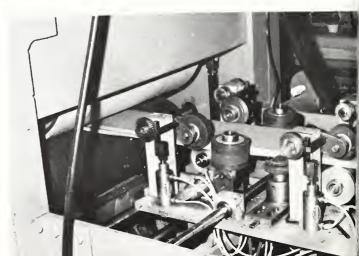
## **Forest Products Utilization**

# Lumber repair—key to use of overlays

The feasibility of upgrading low-grade ponderosa pine with fiber overlays (fig. U-1) is seriously complicated by open defects in the lumber. Tests show that about 65 percent of grade 3 Common, 80 to 85 percent of grade 4 Common, and over 95 percent of grade 5 Common boards must be repaired if they are to be overlaid successfully. Knotholes along the edges of the boards are most serious since they involve two intersecting surfaces. Badly chipped knots and pulled or torn grain are also troublesome.

Foam-type resins offer promise for repairing these defects. The most difficult requirement is that the patch material must shrink and swell with the surrounding wood when its moisture content changes (figs. U-2, U-3).





13 Figure U-2. --Foam-type resin patches. Before 14 overlaying 10 After overlaying The sunken areas are caused by the failure of the patch material to expand equally with the wood following moisture uptake. 10 Figure U-3.--Delamination along edge of patch caused by dimensional change in wood following moisture pickup. In sample A, delamination extends to the board surface. In sample B, the thin projection of patch illustrates one possible way of preventing the separation from

reaching surface.

# Composting—possible solution to the bark disposal problem

Bark from ponderosa pine, Engelmann spruce, and lodgepole pine (fig. U-4) can be converted to a forest litter or dufflike material by composting. Composted bark has potential for a mulch for gardening, landscaping, or horticultural uses. It also may be useful as a soil amendment.

At present, nearly all bark and sawdust produced by sawmills is burned. Increasing public concern over air pollution indicates a need for alternative ways of disposing of these wastes.

Technical studies have shown that composting time can be shortened if nitrogen is added to the bark. Adding nitrogen also reduces the carbon-nitrogen ratio of the final composted material. This is necessary in agricultural applications to avoid causing a nitrogen deficit in growing plants.



Figure U-4.--Raw bark from the debarker on its way to be ground in a hammermill.



Figure U-5.-Ponderosa pine stumps in old cut-over area of forests in northern Arizona, a possible new source of naval stores.

### Ponderosa pine stumps in Southwest are potential resource for naval stores

Ponderosa pine in the Southwest is one of the more promising possible new sources of stumpwood for the wood naval stores industry. The industry, historically located in the South, is facing a steadily declining supply of old-growth pine stumpwood. The Rocky Mountain Station is cooperating in preliminary evaluations of the quality of extractives from ponderosa pine stumps in the Southwest (fig. U-5).

Fifteen stumps selected on the Coconino National Forest, Arizona, were analyzed by the Naval Stores Laboratory, U. S. D. A. Agricultural Research Service, Olustee, Florida. Extractive material averaged approximately 30 percent of the weight of the wood, and was made up of 75 percent resin, 12 percent turpentine, and 13 percent pine oil. Further investigation is needed, however, to determine methods of separating objectionable substances from each product. Estimates of available stumpwood are being developed.

Scaling by weight feasible for southwestern ponderosa pine saw logs

Scaling by weight, as a less time consuming and expensive alternative to conventional stick scaling, gave accurate estimates of board-foot volumes in field tests with southwestern ponderosa pine.

Data were obtained from 539 sample loads of logs in a cooperative study with the Southwestern Region of the U. S. Forest Service, the Coconino National Forest, and the Southwest Forest Industries, Inc. A computer program was used to calculate scaling tables, based on weight and number of logs in the load. Errors in estimated Scribner Decimal C scale, for average loads of all sizes, varied from 1.25 to 2.5 percent. Load weight and log count accounted for 98 percent of the variability in scale volume. Additional variable suspected of contributing to variation—percent defect, blackjack-yellow pine load mix, long log-short log load mix, and season of the year—were not significant.

Mills that want to use regression-based weight scaling should develop tables based on load data from their particular logging operations and scale facilities. Stick scaling should be continued for a subsample of loads, to provide an independent check and a basis for periodic adjustment of the tables in case timber characteristics change.

Timber size greatly affects logging productivity in ponderosa pine

Timber size is a major factor influencing logging productivity in ponderosa pine sawtimber (fig. U-6). On two sale units representing the range of timber sizes, the unit with small timber required more than twice as much direct labor and heavy equipment time, per thousand board feet logged, as did the unit with large timber. Volume cut per acre and terrain were similar on the two sites. Average tree or log size was the most important single determinant of logging productivity for all three woodlogging functions: felling and bucking, skidding, and loading.

Variables that influence productivity may be useful in predicting production rates, and therefore logging costs. Additional work is being done on how productivity is affected by timber volume cut per acre, terrain, and surface rock conditions.

Figure U-6.--Ponderosa pine logs being loaded in the woods. Size of log is a major factor in logging productivity and costs.



# Forest Products Marketing



Black Hills ponderosa pine yields veneer suitable for C-D grade plywood

A sample of 144 ponderosa pine trees from eight sites in the Black Hills of South Dakota yielded 47 percent grade C and better veneer and 53 percent grade D and lower (fig. M-1). This mix of veneer grades is highly favorable for producing a C-D grade of plywood. The square-foot yield of 3/8-inch C-D plywood that could be produced from this veneer was more than three times the board-foot scale of logs used. This is well above the average for the plywood industry. These results are from the first study of a series designed to analyze the technical, economic, and market feasibility of plywood production in the Black Hills.

Two promising markets indicated for overlaid low-grade lumber

A study of the marketability of overlaid lumber products identified molding and siding as the most

Figure M-1.--A sample of Black Hills ponderosa pine logs yielded
47 percent grade C and better veneer.

promising of 20 prospective products (figs. M-2, M-3). Related technical research shows that much of grades 3 and 4 Common ponderosa pine lumber, now often sold at a loss, could be utilized in higher value products when overlaid with a special paper-like material. Research is continuing to determine how well overlaid molding and siding will compare in cost and performance with established products of these types.

Residential shelving, fascia boards, stadium seating, and door jambs proved to be less promising as end uses for overlaid low-grade ponderosa pine. Although these products initially looked promising, they failed to meet marketability criteria.



Figure M-2.-Installation of experimental siding made of overlaid lumber.

Analysis of national plywood markets shows new gains for the South

An analysis of 1966 production and shipment data for the United States softwood plywood industry revealed a substantial increase in southern pine plywood production, but little change in the market areas served. In 1966, southern pine plywood shipments totaled 771 million square feet, 3/8-inch basis. This figure represented 10 percent of the national output, and was up from 3 percent, or 294 million square feet, in 1965.

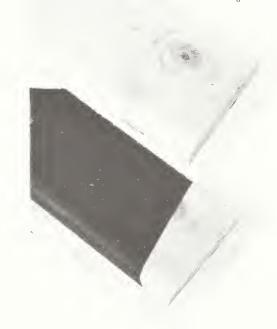
Largest markets for southern pine plywood are in the Mid-Atlantic, South Atlantic, Lake States, Lower Delta, and South Central market areas.

Most plywood used in Arizona is distributed through wholesale and retail dealers

Wholesale and retail dealers play key roles in plywood distribution in Arizona; very little plywood is purchased directly from the mill by users or by retailers. Further, most plywood bought by Phoenix Trade Area firms is used within the area. Of the 58 million square feet that dealers reported selling in 1966, only 2 million square feet were sold outside the trade area.

These findings are part of the results of a pilot study in the Phoenix Trade Area, which includes about three-fourths of Arizona. Methods developed from this pilot study are now being used to analyze plywood distribution and use in other trade areas. These studies are intended to help the plywood industry better serve consumers.

Figure M-3.--Low-grade ponderosa pine molding before and after overlaying.



Use of plywood in Arizona homes increases

A 1962 study of plywood use in the Southwest reported an average use in single-family homes of 1.18 square feet of plywood per square foot of floor area. A recent survey of the Phoenix Trade Area (about three-fourths of Arizona) showed that average use per home in 1966 was 1.64 square feet. This indicates that use of plywood in single-family homes in Arizona has increased by nearly 40 percent in only 4 years. The largest single use for plywood was in roof sheathing.



### Aldon, Earl F.

Detrimental effect of Russianthistle on semidesert range in west-central New Mexico. U. S. Forest Serv. Res. Note RM-109. 2 pp.

Ground cover of perennial grasses declined seriously under plots covered overwinter with dead thistle plants.

Moisture loss and weight of the forest floor under polesize ponderosa pine stands. J. Forest. 66: 70-71. Between 0.16 and 1.09 inches of moisture were lost from the forest floor on plots of pole-size ponderosa pine during part of the summer thundershower period in Arizona. This represented a loss of from 7 to 27 percent of gross precipitation. Stand age offered a good estimate of weight of the forest floor on these plots.

### Alexander, Robert R.

Natural reproduction of spruce-fir after clearcutting in strips, Fraser Experimental Forest. U. S. Forest Serv. Res. Note RM-101, 4 pp., illus.

Numbers and stocking of seedlings and saplings on 1-, 2-, 3-, and 6-chain-wide clearcut strips were determined after logging in 1956, and in 1966. Reproduction in 1966 will provide a satisfactory replacement stand on all strip widths tested, but it is largely advanced growth that survived logging. Both advanced and subsequent reproduction is predominantly subalpine fir, but there is enough Engelmann spruce to provide an adequate representation of this more valuable species in the replacement stand on all strip widths.

### Baldwin, Paul H.\*

Woodpecker feeding on Engelmann spruce beetle in windthrown trees. U. S. Forest Serv. Res. Note RM-105, 4 pp., illus.

Northern three-toed and hairy woodpeckers feeding at windthrown Engelmann spruce trees infested with <a href="Dendroctonus">Dendroctonus</a> obesus (Mann.) caused 70-79 percent mortality of insect brood. Predation under these conditions appears important in declining infestations.

### Bergen, James D.

Atmospheric humidity measurement near the snow surface. U. S. Forest Serv. Res. Note RM-116, 4 pp., illus. Describes a technique for measuring atmospheric humidity in the first few centimeters over a snow cover. Results are presented for four observation periods. The water vapor density at a nominal reference level of 2 cm. above the snow surface was found to vary from less than 20 percent to 90 percent of the density corresponding to saturation at the snow surface temperature. Little diurnal variation was found for the Bowen ratio. Possible remedies for difficulties encountered in the measurements are described.

Some measurements of air permeability in a mountain snow cover. Int. Ass. Sci. Hydrol. Bull. 13(3): 5-13, illus.

Air permeability and density at various levels in an annual mountain snow cover were measured on three separate days in mid-February, early March,

\*Private, State, or Federal cooperator.

and late March. Permeabilities are presented together with the estimates of grain size based on the empirical correlations between grain size and air permeability found in the literature.

Some observations on temperature profiles of a mountain snow cover. U. S. Forest Serv. Res. Note RM-110, 7 pp.

Measurements of the vertical temperature distribution in an annual mountain snow cover are discussed in terms of a simple model of the vertical temperature profile. The parameters describing this model are compared for measurements made for 2 winters. Day-to-day variation is found to be larger for these parameters than between different months of the same winter or between the 2 winters.

### Boldt, Charles E.

Survival and early growth of ponderosa pine planting stock in the Black Hills. U. S. Forest Serv. Res. Note RM-97, 4 pp., illus.

"Average" 1-0, 2-0, 1-1, and 2-1 seedlings were handplanted in contour furrows on a marginal and a favorable planting site in 2 consecutive years. Favorable moisture limited severity of tests in both years. On the basis of third-year survival and fifth-year average heights, it was concluded that 2-0 stock should be planted operationally for enough years to verify or discount its economic advantage over 2-1 stock.

### Campbell, C. J., and Green, Win.

Perpetual succession of stream-channel vegetation in a semiarid region. J. Ariz. Acad. Sci. 5(2): 86-89, illus. The channel vegetation probably never reaches a climax hierarchy due to periodic flood distrubances such as erosion, inundation, and deposition and as a result, mosaics of various seral stages with different dominant species characterize the vegetation communities.

### Campbell, R. E.

Production capabilities of some upper Rio Puerco soils of New Mexico. U. S. Forest Serv. Res. Note RM-108, 7 no.

Variability of plant cover within short distances is due primarily to availability of water. Even though the eight soils sampled varied from native to cultivated lands, from fine sands to firm clays, and from river bottoms to high plateaus, they were normal in moisture-holding capacity, pH, and other physical and chemical characteristics.

### Chansler, John F.

Douglas-fir beetle brood densities and infestation trends on a New Mexico study area. U. S. D. A. Forest Serv. Res. Note RM-125, 4 pp., illus.

The density of callow adult beetles before flight is a good indicator of the trend an infestation will take. It should be possible to devise a systematic sampling system to determine adult numbers that would enable the entomologist to predict infestation trends quite accurately.

Clary, Warren P., Ffolliott, Peter F., and Jameson, Donald A. Relationship of different forest floor layers to herbage production. U. S. D. A. Forest Serv. Res. Note RM-123, 3 pp., illus.

Herbage production decreases as individual layers and total depth of ponderosa pine forest floor increases.

The H layer or total depth of the forest floor accounts for more variation in herbage production than the L or F layers. Management practices which remove only the L and F layers of the forest floor cannot be expected to increase herbage production appreciably.

Davidson, A. G., \* and Prentice, R. M. \* (ed.)

Important forest insects and diseases of mutual concern to Canada, the United States and Mexico. Compiled... from...reports...North American Forestry Commission, FAO. 248 pp., illus. Canada Dep. Forest and Rural Devel., Ottawa.

Nine of the 65 reports were contributed by Rocky Mountain Station personnel.

Andrews, S. R. Adelopus needle cast. pp. 171-172, illus.

Hawksworth, Frank G. Dwarf mistletoes pp. 31-35, illus.

\_\_\_\_\_ Mistletoes. pp. 232-234, illus. Massey, C. L., and Lara, R. Rodriguez. Arizona five-spined engraver. pp. 218-220, illus.

\_\_\_\_\_ and Lara, R. Rodriguez. Larger Mexican pine beetle. p. 217.

and Lara, R. Rodriguez. Round-headed pine beetle. pp. 210-212, illus.

Peterson, G. W. Cedar Blight, pp. 55-56.

Wygant, N. D., and Lara, R. Rodriguez. Pine engraver. pp. 117-119, illus.

and Lejeune, R. R. Engelmann spruce beetle. pp. 92-95, illus.

Davidson, Walter H., and Dawson, David H.

Trees and shrubs for roadside beautification. Dakota Farmer, pp. 33-35, illus, April 6, 1968.

Describes the where, when, what, and how of roadside plantings for beautifying Dakota highways. Species to use are tabulated for different soil types.

Davis, Edwin A.

A laboratory chamber for rooting cuttings. Bot. Gaz. 129: 86-89, illus.

Features of the chamber include: small size (designed for laboratory bench); plastic-covered inclosure; intermittent mist system; incandescent illumination; running-water-bath filter for absorbing infrared radiation emitted by the lamps; day-length control; airtemperature control; and rooting-medium temperature control. Venturi-type atomizers draw distilled water from a reservoir to which nutrients, growth substances, vitamins, antibiotics, etc., can be added. Equipment was used successfully to root softwood cuttings of shrub live oak (Quercus turbinella Greene).

Ingebo, P. A., and Pase, C. P.

Effect of a watershed treatment with picloram on water quality. U. S. Forest Serv. Res. Note RM-100, 4 pp., illus.

A watershed treatment of soil-applied picloram pellets for the control of chaparral brush resulted in the movement of detectable amount of picloram into the stream water. The highest concentration found was 0.37 p.p.m. After 16 months and 40 inches of accumulated rainfall, picloram was no longer detectable in the stream water.

Davis, James R.

Freeze drying for preparing Arizona chaparral plants for energy analysis. U. S. Forest Serv. Res. Note RM-106, 2 pp.

Freeze drying yields more crude fat than ovendrying, and does not adversely affect energy measurements. Therefore, freeze drying is preferred for preparing chaparral fuel samples for chemical analysis.

\_\_\_\_, Ffolliott, Peter F., and Clary, Warren P.

A fire prescription for consuming ponderosa pine duff. U. S. Forest Serv. Res. Note RM-115, 4 pp.

A "hot" prescribed fire was set in October 1964 to burn a specific quantity of litter in ponderosa pine. This objective was accomplished; other effects, which may be beneficial under some circumstances, included thinning of the overstory from below, increased seedling germination, and temporary reduction of fire hazard. Forage and browse were not benefited.

Dietz, Donald R., and Tigner, James R.\*

Evaluation of two mammal repellents applied to browse species in the Black Hills. J. Wildlife Manage. 32: 109-114.

Two mammal repellents, ZAC (zinc dimethyldithiocarbamate cyclohexylamine complex) and TMTD (tetramethylthiuram disulfide) were applied to selected browse species in the Black Hills of South Dakota. Protection was tested by measuring current annual twigs removed during the period of winter use by white-tailed deer (Odocoileus virginianus) and mule The repellents effectively deer (O. hemionus). protected chokecherry (Prunus virginiana), American plum (Prunus americana), aspen (Populus tremuloides), and caragana (Caragana arborescens) from deer browsing. Use by deer on untreated native chokecherry plants varied from 21.8 to 43.9 percent, with a mean of 28.9 percent; use of TMTD treated plants varied from 2.1 to 17.4 with a mean use of 0.7 percent. Both repellents protected aspen shoots almost as effectively as caging. ZAC was also applied to caragana and plum nursery transplants, and significantly prevented browsing by deer. Mammal repellents provide an alternative to expensive and laborious fencing and caging of experimental plants and plots, and also may be useful in browse revegetation projects.

Evans, Keith E.

Characteristics and habitat requirements of the greater prairie chicken and sharp-tailed grouse—A review of the literature. U. S. Dep. Agr. Conserv. Res. Rep. 12, 32 pp., illus.

Permanent grassland and winter food are critical for prairie chickens; grassland with patches of brush or trees provide necessary habitat for sharptails. Both species prefer elevated, open sites for spring courtship displays. Birds return to the same area year after year.

Fencing stockponds benefits waterfowl. Colo. Field Ornithol. 4: 3-4, illus.

Emergent vegetation around fenced stockponds can provide nesting habitat to help offset losses due to pothole drainage.

Ffolliott, Peter F., Clary, Warren P., and Davis, James R. Some characteristics of the forest floor under ponderosa pine in Arizona. U. S. D. A. Forest Serv. Res. Note RM-127, 4 pp., illus.

Timber basal area was the only stand or site variable tested that was significantly related to amounts of

individual layers or total forest floor. Frequency distributions of forest floor depths were developed to be used as a management tool when critical ranges of depths affecting wildland products are defined.

\_\_\_\_ and Hansen, Edward A.

Observations of snowpack accumulation, melt, and runoff on a small Arizona watershed. U. S. D. A. Forest Serv. Res. Note RM-124, 7 pp., illus.

Intensive measurements of snow and streamflow on a 425-acre ponderosa pine watershed indicated that more than 90 percent of the snowpack left the watershed as runoff. Timber stocking was inversely related to snow accumulation, indicating a possibility for increasing snow accumulation by reducing timber stocking.

Galt, H. D.,  $^{\ast}$  Ogden, Phil R.,  $^{\ast}$  Ehrenreich, J. H.,  $^{\ast}$  Theurer, Brent,  $^{\ast}$  and Martin, S. Clark.

Estimating botanical composition of forage samples from fistulated steers by a microscope point method. J. Range Manag. 21: 397-401, illus.

A microscope point method was used to develop weight prediction equations for plant species in masticated forage samples. With 400 microscope points, the average weight of a species was estimated within 5 percent of the mean at a 90 percent level of probability when the species constituted 30 to 60 percent of the sample weight.

Gary, Howard L.

Soil temperatures under forest and grassland cover types in northern New Mexico. U. S. D. A. Forest Serv. Res. Note RM-118, 11 pp., illus.

Temperatures for selected soil depths (1.5 to 112 inches) under aspen, Douglas-fir, spruce-fir, and grassland types on north- and south-facing aspects from 9,900 to 11,150 feet above m.s.l. are reported for 1 year. Plant cover type was more important in modifying soil temperature than aspect, elevation, or snow cover. Average annual temperature for the first 12 inches of soil ranged from 33.2°F. on the north-aspect spruce-fir at 11,150 feet to 40.8°F. on the south-aspect aspen at 9,900 feet. Depth of freezing temperatures during the period of snow cover ranged from 1.5 to 3 feet.

Gilbertson, R. L.,\* Lombard, Frances F.,\* and Hinds, T. E.

Veluticeps berkeleyi and its decay of pine in North
America. Mycologia 60: 29-41, illus.

Widely distributed wood-rotting fungus in North America, <u>V. berkeleyi</u> is apparently present through much of natural range of <u>Pinus ponderosa</u> in western United States; occurs on other pines in Central America and Cuba. It causes a brown cubical heartrot in living trees and a saprot in down timber. <u>V. fusca</u> is placed in synonymy with <u>V. berkeleyi.</u>

Gottfried, G. J., and Campbell, C. J.

A shielded thermistor probe with portable instrument for measuring snowpack temperatures. U. S. D. A. Forest Serv. Res. Note RM-120, 3 pp., illus.

A phenol-resin-based shield has been designed to protect a thermistor probe that can be inserted into a snowpack. The shield also serves as an insulator between the thermistor and the aluminum pole used to push the probe assembly into the snowpack. With the probe and Wheatstone bridge circuit, temperatures can be measured within the snowpack to 0.1°C.

Hansen, Edward A., and Ffolliott, Peter F.

Observations of snow accumulation and meltin demonstration cuttings of ponderosa pine in central Arizona. U. S. Forest Serv. Res. Note RM-111,  $12~\rm pp.$ , illus.

A clearcut block on a north aspect and strips with widths of one and one-and-one-half times tree height on an east aspect increased snow accumulation and increased rates of melt and daily water loss. A strip three-fourths as wide as tree height on a west aspect increased snow accumulation. None of the strips cut on south and southwest aspects affected snowpacks measurably.

Hansen, R. M., and Morris, M. J.

Movement of rocks by northern pocket gophers. J. Mammalogy 49: 391-399, illus.

The relationship between composition of sizes of rocks in soils and digging behavior of Thomomys talpoides was studied in southwestern Colorado. Comparisons were made of the size-classes of rock in (1) the topsoil, (2) the soil mounds pushed to the surface in summer by pocket gophers, and (3) soil casts formed in winter by pocket gophers. Pocket gophers tended to avoid rocks larger than 2.5 cm. diameter. They moved relatively fewer rocks to the surface when the soil was dry, and when the soil contained only a few large rocks. Rocks that were from 0.6 cm. to 2.5 cm. diameter were more abundant in mounds and casts than they were in the topsoil.

Hawksworth, Frank G.

Lodgepole pine dwarf mistletoe on ponderosa pine. U. S. Agr. Res. Serv., Plant Dis. Rep. 52: 125-127, illus.

Arceuthobium americanum, the lodgepole pine dwarf mistletoe, is more common on ponderosa pine than previous reports suggest. Pinus ponderosa var. scopulorum is more susceptible than var. ponderosa. In northern Colorado, this mistletoe occurs in pure ponderosa pine (var. scopulorum) stands several miles from the closest infection on lodgepole pine. In this area it is most abundant in ponderosa pine stands outside the range of the common ponderosa pine dwarf mistletoe (A. vaginatum subsp. cryptopodum).

Ponderosa pine dwarf mistletoe in relation to topography and soils on the Manitou Experimental Forest, Colorado. U. S. Forest Serv. Res. Note RM-107, 4 pp., illus. Marked variations in dwarf mistletoe frequency on three soil types (granitic, limestone, and arkose) apparently were related to variation in slope steepness, with frequency highest on areas with gentle slopes. Stands on soils with a high proportion of gentle slopes (for example, arkose) had most dwarf mistletoe; those on predominately steep slopes (for example, granite) had much less infection.

Estabrook, G. F., and Rogers, D. J. Application of an information theory model for character analysis in the genus Arceuthobium (Viscaceae). Taxon 17: 605-619, illus.

The dwarf mistletoes are used as an example of a new model for analyzing the usefulness of characters in numerical taxonomy. The analyses show the quantity of information in each character, and the relationship of each character to all others and to the resulting classification.

Lightle, Paul C., and Scharpf, Robert F.\*

Arceuthobium in Baja California, Mexico. Southwest.

Natur. 13: 101-102.

Two dwarf mistletoes are known: A.campylopodum f. campylopodum occurs in the Sierra Juarez and Sierra San Pedro Martir on Pinus jeffreyi and P. coulteri; A. campylopodum f. divaricatum was found in the Sierra Juarez on Pinus quadrifolia. This is first report of pinyon dwarf mistletoe from Mexico, and the first on P. quadrifolia.

\_\_\_ and Staley, John M.

Rhizosphaera kalkhoffii on spruce in Arizona. U. S. Arg. Res. Serv. Plant Dis. Rep. 52: 804-805, illus. The needle cast fungus, Rhizosphaera kalkhoffii Bub., is damaging to planted blue spruce, Picea pungens, in many parts of the world, but it was not previously known in native blue spruce stands. It also attacks native Engelmann spruce, P. engelmannii, a new host for the fungus. Damage to spruce stands in Arizona is negligible.

Stewart, James L.,\* and Bailey, Wilmer F.\* You can save your pines from dwarf mistletoe. U. S. Forest Serv. Res. Pap. RM-35, 20 pp., illus.

Illustrated with cartoon drawings, describes practical methods to use in protecting trees of ornamental or recreational value from destruction by dwarf mistletoe. Heede, Burchard H.

Conversion of gullies to vegetation-lined waterways on mountain slopes. U. S. D. A. Forest Serv. Res. Pap. RM-40, 11 pp., illus.

Four gullies were successfully converted to waterways on slopes of the Rocky Mountains in Colorado. Three years after treatment, they had lost only 9 percent as much soil as comparable untreated gullies. Careful engineering survey and design, close construction supervision, and good response to revegetation measures were responsible for the success. Since limits of applicability could not be established, the method is proposed for application on sites comparable to those of the study area.

Engineering techniques and principles applied to soil erosion control. U. S. Forest Serv. Res. Note RM-102, 7 pp., illus.

Two basic approaches to erosion control are (1) resisting natural forces, and (2) utilizing them. Examples of (1) are check dams and grassed waterways; of (2), Italian hydraulic reclamation where erosive forces are used to stabilize watersheds. Objective of both is to establish a vegetation cover. (Also published in proceedings of Panamer. Soil Conserv. Congr., 1st Congr., v. 1, sect. 1, pap. 6, 16 pp.).

Heidmann, L. J.

Herbicides for preparing ponderosa pine planting sites in the southwest. Down to Earth 24: 18-20, illus. (Also published as U. S. Forest Serv. Res. Note RM-83.) In 1961 and 1962, dalapon, bisester of dalapon, simazine, amitrole, amitrole-T, and ammonium thiocyanate were tested on perennial grasses in Arizona. All of the herbicides except ammonium thiocyanate effectively killed the grass. Dalapon, however, was the cheapest effective herbicide.

Silvicultural control of dwarf mistletoe in heavily infected

stands of ponderosa pine in the southwest. U. S. Forest Serv. Res. Pap. RM-36, 11 pp., illus.

Three treatments—limited control by harvest cutting and stand improvement, complete control, and light improvement selection—were tested. Limited control appeared impractical. Silvicultural control of heavy infections required almost complete stand destruction. Severely opened stands were highly susceptible to windthrow; clearcutting seems indicated.

Hinds, T. E., Davidson, R. W.,\* and Lombard, Frances F.\*

Decay of Engelmann spruce by Lentinellus montanus
in Colorado. U. S. Agr. Res. Serv. Plant Dis. Rep.
52: 820-821, illus.

A series of cultures isolated between 1944 and 1958 from decayed wood in living Engelmann spruce and lodgepole pine in Colorado have been identified as Lentinellus montanus O. K. Miller, which was described in 1965. The fungus causes a white rot which is usually associated with old fire scars, and is described as a yellow stringy butt rot of the heartwood.

Jameson, Donald A.

Species interactions of growth inhibitors in native plants of northern Arizona. U. S. Forest Serv. Res. Note RM-113, 2 pp.

Extracts of most plants contain materials that inhibit the growth of seedlings, but the effect of inhibitors from different species varies with the test seedlings used. These interactions demonstrated in the laboratory may also be important in interspecific relationships in the field.

Judson, Arthur.

Snow cover and avalanches in the high alpine zone of western United States. <u>In</u> Physics of snow and ice, edited by Hirobumi Oura. Int. Conf. Low Temp. Sci. (Sappora, Japan) Proc. 1966: 1151·1168, illus.

A brief analysis of the characteristics of 80 avalanche tracks in Colorado, and the frequency and type of avalanches, shows that slab avalanches account for more than 80 percent of all occurrences, and soft slabs are most frequent. Avalanche hazard forecasting with reference to the use of snowpits and weather data in the High Alpine Zone is discussed; and a method of using precipitation data to determine when to start avalanche control action during major storms is outlined.

Kennedy, Patrick C.

Insects and diseases of Siberian pea shrub (caragana) in North Dakota, and their control. U. S. Forest Serv. Res. Note RM-104, 4 pp., illus.

Grasshoppers do most damage. Malathion is recommended to control most insects; Bordeaux mixture for Septoria leaf spot.

Kerbs, Roger R., and Messner, Harold E.

A hand seed divider and method for planting experimental plots. J. Range Manage. 21: 179-180, illus. Quick, precise, and even seed distribution was obtained with a plastic seeding device and wood trough, both of which cost less than \$7 for material and required less than four man-hours for construction. These two items appreciably reduced the time required to plant grasses and legumes on small experimental plots.

Knipe, O. D.

Effects of moisture stress on germination of alkali saca-

ton, galleta, and blue grama. J. Range Manage. 21: 3-4, illus.

Seeds of these three species were germinated in media representing moisture tensions of 0, 1, 4, 7, 10, 13, and 16 atmospheres. Alkali sacaton germination was most severely affected by moisture stress, which helps to explain, at least in part, why alkali sacaton plants are confined mainly to areas that are frequently flooded. In contrast, galleta and blue grama are less affected by moisture stress and, therefore, can become established and survive on the drier upland sites.

Lavin, Fred,\* Jameson, Donald A., and Gomm, F. B.\*

Juniper extract and deficient aeration effects on germination of six range species. J. Range Manage. 21: 262-263.

Juniper foliage extract significantly decreased seed germination for three of six range species tested. Deficient aeration severely decreased germination for two species and completely inhibited germination of the other four.

Leaf, Charles F.

Management of forested watersheds to improve water yield. Nat. Ass. Soil and Water Conserv. Dist. Proc. 22: 81-82.

Removal in 1955 of aproximately 50 percent of the merchantable volume of timber from a high mountain watershed in central Colorado has resulted in increased annual water yields of more than 25 percent. Twelve years have lapsed without any indication that the effect of harvest cutting on streamflow has diminished. This new information suggests that timber harvesting can be an important and economically feasible method of providing additional water supplies.

Lightle, Paul C., and Andrews, Stuart R.

Red rot in residual ponderosa pine stands on the Navajo Indian Reservation. U. S. Forest Serv. Res. Pap. RM-37, 12 pp., illus.

Data revealed that red rot cull amounted to 15 percent of gross volume of virgin stand. Tree age was most significant factor studied. Bark color in the lower trunk was a better criterion of red rot cull than broad age classes based on actual or estimated ages. Current marking system removed 48 percent of gross volume; 68 percent of red rot volume.

Lloyd, R. Duane

Multiple use and multiple responsibilities. Colo. State Univ. Annu. Short Course in Game and Fish Manage. Proc. 4: 104-112, illus.

Public servants, responsible for management of natural resources, must realize that resources exist for man. The more each manager realizes his job is to deal with people, the better he is able to manage the people's game, fish, and other resources.

McKnight, M. E.

A literature review of the spruce, western, and 2-year-cycle budworms. U. S. D. A. Forest Serv. Res. Pap. RM-44, 35 pp.

Covers 370 literature citations on the spruce (<u>C. fumiferana</u> (Clemens)), western (<u>C. occidentalis</u> Freeman), and 2-year-cycle (<u>C. biennis</u> Freeman) bud-

worms through November 1967. Citations are also organized in a subject index.

The 24-inch branch as a sample unit for egg mass surveys of the western budworm. U. S. D. A. Forest Serv. Res. Note RM·122, 2 pp.

Estimates of the density of western budworm (Choristoneura occidentalis Freeman) egg masses on needles of Douglas-fir are not different on a 24-inch branch sample and the conventional half-branch sample. The smaller 24-inch branch sample is gathered by a small field crew using a pole pruner. The foliage can be gathered in one-third the time and examined in the laboratory in half the time required for half-branch samples.

Mace, Arnett C., Jr.

Effects of soil freezing on water yields. U. S. D. A. Forest Serv. Res. Note RM-121, 4 pp., illus.

Concrete and granular types of soil freezing in the White Mountains of Arizona influence the disposition of snowmelt water. Concrete frost occurs in the open grassland areas, and appears to increase surface runoff. Only granular frost occurs in the timber types, and appears to decrease surface runoff and increase soil moisture recharge. Concrete freezing causes increased soil moisture and reduced bulk densities in the zone of freezing, whereas granular freezing has no effect on these properties.

Mueller, Lincoln A., Markstrom, Donald C., and Lutz, John F.  $^{\circ}$ 

Preliminary evaluation of small-diameter Black Hills ponderosa pine for veneer and plywood. U. S. D. A. Forest Serv. Res. Note RM-117, 11 pp., illus.

Logs 8 to 15 inches in diameter produced veneer suitable for sheathing-grade plywood. Veneer cutting and drying presented no particular problems.

Myers, Clifford A.

Simulating the management of even-aged timber stands.

U. S. D. A. Forest Serv. Res. Pap. RM-42, 32 pp. Presents a computer program, written in Fortran IV, for simulation of the management of even-aged timber stands. Changes computed include tree growth, harvest cuts, periodic thinnings, and catastrophic losses. Annual costs and returns are summarized in various statements of money value.

\_\_\_\_\_ and Godsey, Gary L.

Rapid computation of yield tables for managed, evenaged timber stands. U. S. D. A. Forest Serv. Res. Pap. RM-43, 16 pp.

Sets of yield tables that show probable results of various management alternatives can be valuable tools for decisionmaking, especially when they can be made available quickly and at relatively low cost. Such tables can be obtained with data from temporary plots and the computer programs presented. Orr. Howard K.

Soil-moisture trends after thinning and clearcutting in a second-growth ponderosa pine stand in the Black Hills. U. S. Forest Serv. Res. Note RM-99, 8 pp., illus.

Clearcutting apparently induced free water seepage to ground water even in relatively dry years; thinning from 190 square feet basal area per acre to 80 square feet apparently did not, although it did increase seepage potential.

Pase, C. P., and Fogel, Martin M.\*

Increasing water yield from forest, chaparral, and desert shrub in Arizona. <u>In</u> Int. Conf. on Water for Peace Proc. v 2, pp. 753-764, illus.

Summarizes research on forest and chaparral lands to develop techniques for decreasing evapotranspiration losses and increasing water yield. Altering soil surface characteristics that affect infiltration may also increase water yields from desert shrub lands.

and Johnson, R. Roy.\*

Flora and vegetation of the Sierra Ancha Experimental Forest, Arizona. U. S. D. A. Forest Serv. Res. Pap. RM-41. 19 pp., illus.

Brief description of eight plant associations found on the Experimental Forest. The checklist includes 726 species and 9 varieties of vascular plants collected over a period of 35 years. Geographical affinities indicate the flora is distinctly southwestern and western, with approximately 70 percent of all known species falling in these groups.

\_ and Thilenius, John F.

Composition, production, and site factors of some grasslands in the Black Hills of South Dakota. U. S. Forest Serv. Res. Note RM-103, 8 pp.

Major grassland types found were bluegrass and mixed prairie. On prairie type, total herbage and grass production were greater on ungrazed than on grazed range; little difference occurred on bluegrass type. Moist sites are dominated by bluegrasses; drier sites by prairie vegetation.

Patton, David R., Dickie, Robert R.,\* Boeker, Erwin L.,\* and Scott, Virgil E.\*

A transmitter for tracking wildlife. U. S. Forest Serv. Res. Note RM-114, 4 pp., illus.

Schematics are presented for a transmitter with an amplifier stage to increase receiving distance. Weight of the transmitter with one battery is 2 ounces, maximum battery life is 45 days, and maximum receiving distance is 2-½ miles.

Paulsen, Harold A., Jr., and Miller, John C.\*

Control of Parry rabbitbrush on mountain grasslands of western Colorado. J. Range Manage. 21: 175-177, illus.

Parry rabbitbrush was controlled with Tordon 22-K at 2 pounds per acre. Treatments significantly increased grass, with a corresponding decrease in forbs.

Pearson, Henry A.

Range animal nutrition. West Texas Ranch Manage. Conf., (Lubbock, Texas) Proc. 5: 66-82.

Nutrients available for livestock production differ according to forage species, season of growth, plant parts, and location. These differences to a great extent determine animal intake. Digestible forage consumed can be used to estimate animal production more efficiently than forage utilization alone.

Thinning, clearcutting, and reseeding affect deer and elk use of ponderosa pine forests in northern Arizona.

U. S. D. A. Forest Serv. Res. Note RM-119, 4 pp., illus. Logging or slash disposal after thinning may decrease deer but increase elk populations. Deer and elk did not significantly affect forage utilization measurements.

Peterson, Glenn W., Stewart, James L.,\* and Willis, William G.\*

Oak wilt distribution in Nebraska and Kansas. U. S. Agr. Res. Serv., Plant Dis. Rep. 52: 357-358.

Oak wilt has been detected in 6 counties in Nebraska; 12 in Kansas. It was first detected in both States in 1950.

\_ and Wysong, David S.\*

Cercospora blight of junipers: damage and control. U. S. Agr. Res. Serv., Plant Dis. Rep. 52: 361-362. Recently detected in Nebrasks windbreaks, this disease kills trees rapidly—some within 3 growing seasons. Fungicide treatments reduced disease severity during the 2-year study. Further tests will help determine time and rate of applications for economical control.

\_ and Wysong, David S.\*

Diplodia tip blight of pines in the Central Great Plains: damage and control. U. S. Agr. Res. Serv., Plant Dis. Rep. 52: 359-360.

Damage to Pinus nigra, P. ponderosa, and P. sylvestris by Diplodia pinea (Desm.) Kickx. is especially severe in trees over 30 years old in eastern Nebraska. Infection was reduced approximately 50 percent with Bordeaux mixture applied three times at 3-week intervals beginning in mid-May; infection incidence was similar whether or not infected tissue was pruned. Nonsprayed trees, whether pruned or not, had a high level of infection.

Pierce, D. A.,\* McCambridge, W. F., and Moore, G. E.\* Control of pinyon needle scale with dimethoate. J. Econ. Entomol. 61: 1697-1698, illus.

Water emulsion formulations of 0.5 and 1.0 percent dimethoate gave similar and effective results. Addition of a surfactant did not significantly increase mortality. Proper timing is important; spray should be applied to all egg-mass concentrations when eggs begin to hatch.

Pond. Floyd W.

Changes in grass production on ungrazed chaparral. U. S. Forest Serv. Res. Note RM-98, 4 pp., illus.

Ungrazed stands of weeping lovegrass in cleared chaparral begin to deteriorate a few years after treatment. The decline does not appear to be related to brush cover or precipitation.

Conversion of chaparral and scrub hardwood to productive range. Symp. Proc.: Herbicides and vegetation management in forest ranges, and noncrop lands 1967: 214-219, illus.

Results of a 3-year study show that root-plowed and seeded land supported about three times the animals per unit area that chaparral did. Based on beef at 25 cents per pound, gross returns would be \$2.70 per acre from brushlands and \$10 per acre from root-plowed lands. Selling price for chaparral-covered land averages \$24 per acre; brush removal, root plowing, and seeding to grass cost only \$16 per acre—investment is about one-third the amount necessary to buy neighboring brush ranges. The study area was in chaparral type near the old Tonto Springs Ranger Station on the Prescott National Forest in Arizona.

\_ Kukal, James L., and Balmes, Eddie.

Chaparral: a good cow home during deep snow. Ariz. Cattlelog 26(2): 17, 18, 20, 22, illus.

During the heavy snow of December 1967, calves isolated in chaparral pastures on the Tonto Springs Experimental Area, Prescott, Arizona, lost weight but fared better than calves on pastures converted to grass.

Reid, Elbert H.

Finnsheep—a prolific breed. Nat. Wool Grower 58(3): 14.15, illus.

Contrasts the sheep production usually obtained (one ewe-one lamb) with a sheep breed observed in Finland (one ewe-three lambs). Eighty-eight percent of the ewes produce either twins, triplets, or quadruplets. Finnsheep ewes average 120-143 pounds at maturity; rams, 175 to 200 pounds. The wool is said to be lustrous, elastic, soft, and firm, with medullated wool and kemp rare. Finnsheep are shorn in spring and in autumn, with annual average production per ewe of  $5\frac{1}{2}$  pounds of wool.

Reynolds, H. G.

Healthy habitat—the key to wildlife protection in the Southwest. N. Mex. Wildlife 13(5): 6-8, illus.

Big game is an important wildland product in New Mexico. Research has shown that deer and elk benefit from habitat improvement measures, such as creating small clearcuttings in dense spruce-fir forests, selective reduction of forest by logging, partial removal of pinyon-juniper woodland overstory, and planting of proper food and cover.

\_ and Martin, S. Clark.

Managing grass-shrub cattle ranges in the Southwest. U. S. Dep. Agr. Agr. Handb. 162, 44 pp., illus.

Management of grass-shrub range is up to the individual rancher. He alone can control degree of use, season of use, and distribution of grazing. He can manipulate availability of water and salt, distribute grazing pressure, suppress undesirable woody plants.

Rich, Lowell R.

Preliminary water yields after timber harvest on Castle Creek, Arizona watersheds. Ariz. Watershed Symp. Proc. 12: 9-12, illus.

Preliminary measurements indicate increased water yields following timber harvest on West Fork of Castle Creek. Timber harvest treatment included clearcutting one-sixth of the watershed in blocks fitted to overmature and dwarfmistletoe-infected tree classes. The remaining five-sixths of the watershed was placed in the best growing condition possible for the existing ponderosa pine stand.

Riffle, Jerry W.

Effect of an Aphelenchoides species on the growth of mycorrhizal fungi. Nematologica 14: 14.

Paper presented at the annual meeting of the Society of Nematologists at Washington, D. C., August 20-24, 1967.

Pedicularis centrantheca, a parasite of three southwestern tree species. Southwest, Natur. 13: 99-100, illus.

This parasite, found parasitizing roots of <u>Juniperus</u> monosperma, <u>J. deppeana, and Pinus ponderosa in central New Mexico</u>, formed haustoria on small rootlets of hosts, and produced direct connection between its vessels and the tracheids of the hosts.

Plant parasitic nematodes in marginal <u>Pinus ponderosa</u> stands in central New Mexico. U. S. <u>Agr. Res. Serv.,</u> Plant Dis. Rep. 52: 52-55.

Thirty plant-parasitic nematode species representing 14 generawere found associated with marginal Pinus ponderosa and its woodland associates, P. edulis, Juniperus monosperma, J. deppeana, and J. scopulorum in central New Mexico. With the exception of J. scopulorum, all parasitic nematodes combined were more abundant around roots of Juniperus spp. than of Pinus spp. regardless of stand condition. More nematode species were found in non-drought stands than in drought stands.

\_\_\_\_\_ and Springfield, H. W.

Hydrogen peroxide increases germination and reduces microflora on seed of several southwestern woody species. Forest Sci. 14: 96-101, illus.

Washing seeds of <u>Pinus ponderosa</u>, <u>P. edulis</u>, <u>Juniperus monosperma</u>, <u>Atriplex canescens</u>, <u>Cercocarpus montanus</u>, and <u>Cowania mexicana</u> in water for 48 hours, followed by a half hour soak in 30 percent hydrogen peroxide, increased germination of all species except <u>A. canescens</u>. Soaking in water, followed by peroxide treatment, improved seed germination of four species. Soaking or washing without peroxide treatment proved less effective; most water treatments were detrimental to <u>A. canescens</u> and <u>C. montanus</u> seeds. Peroxide treatment effectively reduced seedborne microflora, but induced some abnormal seedling development on the three shrub species.

Rogers, Walter E., and Sommerfeld, Richard A.

A photo-electric snow particle counter. Amer. Geophys. Union Trans. 49: 690. (Abstr.)

Paper presented at Seventh National Fall Meeting, American Geophysical Union, December 2-5, 1968.

Scharpf, Robert F.,\* and Hawksworth, Frank G.

Dwarf mistletoe on sugar pine. U. S. Dep. Agr. Forest Pest Leafl. 113, 4 pp., illus.

Dwarf mistletoe causes serious damage to sugar pine stands in California and southern Oregon. The parasite is found throughout the natural range of sugar pine in the mountains of southern California, in the Sierra Nevada and North Coastal Mountains of California, and in the southern Cascades.

Smith, Dixie R.

Bias in estimates of herbage utilization derived from plot sampling. J. Range Manage. 21: 109·110.

Ocular estimate by plot method may be biased by lack of proper weighting procedures. Nature and magnitude of bias is related to sample size, variability and distribution of yield, and correlation between herbage production and use by livestock. To form unbiased estimates of population mean, individual estimates must be weighted by production.

Springfield, H. W.

Age and year of collection affect germination of winterfat seeds. U. S. Forest Serv. Res. Note RM-112, 2 pp. One- and two-year-old seeds germinated better than older seeds; nevertheless, seeds 4, 5, and 6 years old produced a fair number of seedlings, especially at temperatures of 43°F. and 57°F. Retention of viability appears to be influenced by the year the seeds were collected.

Cold storage helps winterfat seeds retain viability. J. Range Manage. 21: 401-402.

<u>Eurotia</u> <u>lanata</u> seeds from five sources retained higher viability when stored 3 years at  $-5^{\circ}$  to  $-9^{\circ}$  F., and five of six sources retained higher viability when stored  $2\frac{1}{2}$  years at  $38^{\circ}$  to  $42^{\circ}$  F., compared with storage at  $55^{\circ}$  to  $95^{\circ}$  F.

Cold storage not required for fourwing saltbush seeds. J. Range Manage. 21: 335-336.

Seeds refrigerated 4 years germinated no better than seeds stored under ordinary conditions. Viability was retained for 6 years under storage at 55° to 95° F.

Germination of winterfat seeds under different moisture stresses and temperatures. J. Range Manage. 21: 314-316. illus.

Germination of winterfat decreased and was delayed as moisture stress increased. Decreases were proportionately less at lower temperatures, which indicates soil drying may not be as detrimental to germination during cool weather. One of the two sources of seed tested germinated better under all moisture stresses. Further research may reveal certain sources are superior for revegetation.

Staley, John M., Altman, Jack,\* and Spotts, Robert A.\*
A sodium-linked disease of ponderosa pine in Denver,
Colorado. U. S. Agr. Res. Serv., Plant Dis. Rep. 52:
908-910, illus.

A chronic foliar chlorosis and tipburn of ponderosa and other pines in Denver, Colorado is described. Needles of affected trees exhibit tipburn, initiated by a band of resin infiltration followed by chlorosis and eventual necrosis. Examinations and cultural treatments over a 10-year period have implicated no causal agents. More recent analyses show diseased foliage contains abnormally high levels of sodium.

Stein, John D.

Labeling the larvae of the elm sawfly with P<sup>32</sup>. J. Econ. Entomol. 61: 508-510.

Translocation of P<sup>32</sup> into white willow leaves provided enough radioactive food substance to effectively locate tagged fourth-instar larvae with a portable Geiger-Muller counter.

Stelzer, Milton J.

The Great Basin tent caterpillar in New Mexico: life history, parasites, disease, and defoliation. U. S. D. A. Forest Serv. Res. Pap. RM-39, 16 pp., illus.

Malacosoma fragile (Stretch) is epidemic periodically in quaking aspen stands of northern New Mexico. Heavy defoliation for 3 consecutive years decreased annual ring width 75 percent; percentage of dead trees increased from 20 to 70, and almost all survivors had dead tops and branches. Larvae begin to hatch in late May, and feed for 30-42 days (five instars). Eggs are laid from mid-July to early August in masses of up to 250. First-instar larvae pass the winter within the egg chorion. Two species of predators and 49 parasites have been identified in New Mexico and Arizona.

Strasia, C. A., \* Rice, R. W., \* and Smith, D. R.

Diet and gain of free vs. herded sheep in alpine range. J. Anim. Sci. 27: 1186.

Abstract of paper presented at the Western Section, American Society of Animal Science, at Moscow, Idaho, July 7-9, 1968.

Sturges, David L.

Evapotranspiration at a Wyoming mountain bog. J. Soil & Water Conserv. 23: 23-25, illus.

Compares pan evaporation, calculated potential evapotranspiration and actual bog evapotranspiration—all important aspects in bog hydrology. These wetland sites may be useful in altering quantity or timing of streamflow.

Hydrologic properties of peat from a Wyoming mountain bog. Soil Sci. 106: 262-264, illus.

Peat characteristics were measured in the laboratory and in the bog. Both bulk density and water retention were related to degree of decomposition and thus to pore size distribution.

\_\_\_\_\_ and Sundin, R. E.

Gross alpha and beta radiation in waters at a Wyoming mountain bog. Water Resources Res. 4: 159-162, illus. Waters collected between July and October 1965 from four locations at a mountain bog were analyzed for radiologic content. The gross alpha and beta content of waters was less than 5 and 10 pc/liter, respectively. Gross beta activity of filterable solids in groundwater collected above the bog reached 400 pc/gram when the water table was at a seasonal minimum, but on other dates and at the bog and stream locations, the gross beta activity of filterable solids was less than 100 pc/gram. Radiation levels in waters from snow, overland flow, and stream sources were measured in May, June, or October 1965. Snow water activity was less than 25 pc/ liter, but filterable solids had a maximum gross alpha and beta activity of 243 and 1,348 pc/gram, respectively. Standing vegetation, litter, and moss on the bog surface screened radionuclides from snowmelt water. Radionuclide filtration on watersheds is of significance from a public health standpoint.

Swanson, Robert H.

A system for making remote and undisturbed measurements of snow settlement and temperature. West. Snow Conf. Proc. 36: 1-5, illus.

Remote reading of temperature is possible with thermistors mounted on light plastic platters on a guide wire. Platters can be dropped and their position determined from some distance away (10-300 m.) and are relatively free to settle with the snowpack due to a liquid mercury contact with the verticle guide wire.

Tabler, Ronald D.

Physical and economic design criteria for induced snow accumulation projects. Water Resources Res. 4: 513-519, illus.

For an equally spaced series of snow fences, the following concepts apply: (1) Fence spacing may be calculated on the basis of winter precipitation, contributing area, and maximum snow retention capacity. (2)A probability analysis of winter precipitation provides a basis for a weighted physical production function. (3) Optimum scale of development can be determined by means of standard marginal analysis.

Soil moisture response to spraying big sagebrush with 2,4-D. J. Range Manage. 21: 12-15, illus.

Spraying big sagebrush with 2,4-D reduced the rate of soil moisture withdrawal. About 75 percent of the difference in total moisture depletion occurred within the 3- to 6-foot soil depth; an opposite effect in the second foot indicated that the increase in grass herbage production is most strongly reflected in that zone. Total evapotranspiration losses from the 0- to 6-foot soil profile were reduced about 14 percent over the 4-month growing period the second year after spraying.

### Thompson, J. R.

Effect of grazing on infiltration in a western watershed. J. Soil & Water Conserv. 23: 63-65, illus.

Infiltrometer measurements, along with personal observations, suggest that grazing affects infiltration less than seasonal changes in surface soil characteristics.

Troxell, Harry E.,\* and Mueller, Lincoln A.

Solar lumber drying in the central Rocky Mountain region. Forest Products J. 18: 19-24, illus.

Experiments in solar drying at Colorado State University indicate that this drying method should be considered and developed further as a method superior to air drying in many geographical regions. (Paper presented at Session 15, Wood Drying, of the 20th Annual Meeting of the Forest Products Research Society, July 21, 1966, Minneapolis, Minnesota.)

Van Deusen, James L.

Periodic growth of pole-sized ponderosa pine as related to thinning and selected environmental factors. U. S. D. A. Forest Serv. Res. Pap. RM-38, 12 pp., illus.

Diameter growth began earlier in thinned stands and proceeded more rapidly than in unthinned stands. The length of the height growth season averaged about the same for trees in the two stands, but the thinned trees grew a little faster. Beginning or ending of tree growth could not be consistently related to air temperature or calculated degree days. There was, however, a distinct relationship between precipitation and diameter fluctuations for trees growing under a moisture stress.

Van Haverbeke, David F.

A population analysis of <u>Juniperus</u> in the Missouri River Basin. Univ. Nebr. Studies, New Series 38, 82 pp., illus.

Analyses based on a taxonomic evaluation of 38 gross morphological, foliage, cone and seed, and infrared characters of 675 trees indicated an introgressive trend, southeast-northwest over the Basin, from the range of J. virginiana into that of J. scopulorum.

\_\_\_ and Boldt, Charles E.

Vigor and density of shelterbelt conifers can be improved. J. Forest. 187-192, illus.

Release of ponderosa pine and eastern redcedar after 20 years of suppression resulted in increased diameter and height growth, and in decreased mortality rate. Results were best when rows of suppressed conifers were released on both sides.

\_\_ Hill, David F.,\* and Gavit, Richard J.\*

Trees help integrate Nebraska's agricultural resources. Univ. Nebr. Quart. 15(3): 4-7, illus.

Planting shelterbelts in large corners of quartersection irrigated with centerpivot sprinkler systems provides protection that helps integrate production or corn and cattle.

Sullivan, Charles Y.,\* and Davidson, John F.\*

Quantitative differences in extractable lipids yield taxonomic character data in <u>Juniperus</u>. <u>In</u> A population
analysis of <u>Juniperus</u> in the Missouri River Basin. Univ.
Nebr. Studies, New Series 38, 69-81, illus.

Describes a quantitative technique for obtaining a crude lipid extract from <u>Juniperus</u> cone pulp and its analysis by infrared (IR) spectroscopy to obtain chemical character data. Suggests the desirability of this technique as a source of relationship evidence in taxonomic research.

Wardel, Peter.\*

Engelmann spruce (<u>Picea engelmannii</u> Engel.) at its upper limits on the Front Range, <u>Colorado</u>. Ecology 49: 483-495, illus.

Engelmann spruce is the dominant tree at timberline in the Front Range at approximately 3,350 m. elevation; it occurs as krummholz in the forest-tundra ecotone up to about 3,500 m., and occasional individuals are found in the tundra up to 3,730 m. Position of timberline is correlated with summer temperatures, dry winter winds are the immediate, though probably not the ultimate, cause of the krummholz growth forms in the forest-tundra ecotone.

Wiens, Delbert.\*

Chromosomal and flowering characteristics in dwarf mistletoes (Arceuthobium). Amer. J. Bot. 55: 325-334, illus. Part of a continuing systematic and evolutionary study of New World mistletoes. Only chromosome number known in the genus is n=14; karotype appears symmetrical. Flowering characteristics are classified into three groups.

Yerkes, Vern P., Lloyd, R. Duane, and Lewis, Gordon D.\* Softwood plywood in the United States—production and distribution in 1965. U. S. Forest Serv. Res. Pap. RM-34, 23 pp., illus.

U. S. softwood plywood production in 1965 was 12.4 billion square feet. The three West Coast producing regions accounted for 87 percent of this volume. Nearly 70 percent of the production was interior type. Volumes of plywood shipped to each of the 50 Rand McNally Trading Areas and 10 market areas are presented. New York and Chicago are important markets for all producing regions. Market areas adjacent to a producing region also receive a large share of that region's production.

Composting ponderosa pine bark—effects of nitrogen addition and aeration. U. S. D. A. Forest Serv. Res. Note RM-126, 4 pp., illus.

Composting of ponderosa pine bark for 9 weeks resulted in a product with a disappearing bark structure, a darkened color, and an "earthy" odor. The addition of nitrogen and aeration speeded up the composting process.

# COMMON AND SCIENTIFIC NAMES OF ANIMALS AND PLANTS MENTIONED

### Carex exerta Mkze. Stanion hystrix (Nutt.) J. G. Smith Agropyon aristatum (L.) Gaertn. A. triesmedium (Host) Beauv. Elymus junceus Fisch. Pseudotsuga menziesii (Mirb.) Franco Populus tremuloides Michx. Arctostaphylos uva-ursi (L.) Spreng. Ulmus pumila L. Abbes Lastocampa (Hook.) Nutt. A. comcolox (Gord. & Glend.) Lindl., Iuniperus deppeana Steud. Atriplex canescens (Pursh) Nutt. J. communis L. J. scopulorum Sarq. J. osteosperma (Torr.) Little Arctostaphylos Spp. Querus emory: Torr. Q. gambeli: Nutt. Q. turbinella Greene f. flavescens S. Wats. Symphoricarpos albus (L.) Blake Spiraea lucida Greene Mahonia repens (Lindl.) G. Don Ceanothus greggii A. Gray Cercocarpus betuloides Nutt. Iuniperus virginiana L. Elaeagnus angustifolia L. Artemisia tridentata Nutt. Jaragana arbonescens Lam. puntia fulgida Engelm. Picea engelmannii Parry Rhus trilobata Nutt. P. ponderosa Lawson Prunus americana Marsh. C. breviflorus A. Gray Prunus virginiana L. Jarrya wrighti's Torr. Pinus nigra Arnold P. contorta Dougl. 4. frigida Willd. R. ovata S. Wats. Oryzopsis spp. urshia Spp. Juncus Spp. salea sp. Squirreltail, bottlebrush Em. Siberian Fir, subalpine Fir, white Juniper, alliqator Juniper, common Juniper, Rocky Mountain Wheatgrass, intermediate Silktassel, yellowleaf Cercocarpus, birchleaf Wheatgrass, crested Plum, American Redcedar, eastern Russian-olive Snowberry, common Spirea, shinyleaf Spruce, Encelmann Sumac, skunkbush Sagebrush, big Sagebrush, fringed Saltbush, fourwing Oregongrape, low Peashrub, Siberian Silktassel, Wright Cercocarpus, hairy Seanothus, desert Sedge, shorthair Wildrye, Russian Oak, Emory Oak, Gambel Oak, shrub live Shrubs and Trees Cholla, jumpina Pine, Austrian Pine, lodgepole Pine, ponderosa Aspen, quaking Serviceberry Sumac, sugar Douglas-fir Ricegrasses Bitterbrush Chokecherry Manzanita Bearberry Dalea Odocoileus hemionus hemionus (Rafinesque) Odocoileus virginianus coussi (Coues & Yarrow) Odocoileus virginianus dacotensis Goldman & Kellona Jervus canadensis canadensis (Erxleben) Reynolds Anas discors Linnaeus Meleagris gallapavo merriami Nelson Deschampsia caespitosa (L.) Beauv. Muhlenbergia montana (Nutt.) Hitchc. Hordeum jubatum L. Poa longiligula Scribn. & Williams eromyscus maniculatus Wagner Phychomys leucogaster Maximilian Peromyscus true: Shufeldt Geum rossii (R. Br.) Ser. Desmanthus cooleyi (Eaton) Trel. megalotis Baird Trifolium Spp. Erigeron flagellaris A. Gray erognathus apache Merriam Sylvilagus audubonii Baird Dipodomys ordii Woodhouse Citellus leucurus Merriam ynomys leucurus Merriam Antennaria aprica Greene Bromus rubens L. Festuca arizonica Vasey F. idahoensis Elmer epus californicus Gray Peithrodontomys megalo Weotoma lepida Thomas inermis Leyss. thurberi Vasey P. ampla Merr. P. rupicola Nash Descurainia Sp. Bouteloua Spp. Welilotus Sp. ypha spp. PLANTS Deer, white-tailed (Arizona) Deer, white-tailed (South Dakota) Mouse, western harvest Rat, desert wood Rat, Ord's kangaroo Squirrel, white-tailed ground Chess, foxtail (or red brome) Fescue, Arizona Fescue, Idaho Bluegrass, longtongue mutton Bluegrass, Sherman big Bluegrass, timberline Grasses and Grasslike Plants Mouse, northern grasshopper Dog, white-tailed prairie Jackrabbit, black-tailed Mouse, Apache pocket Pussytoes, RockyMountain Sopher, northern pocket Avens, golden (alpine) Bundleflower, James Cottontail, desert Fleabane, trailing Hairgrass, tufted [eal, blue-winged urkey, Merriam's Muhly, mountain Fescue, Thurber Barley, foxtail Brome, smooth Cattails Mouse, piñon **Fansymustard** Mouse, deer Sweetclover Deer, mule Mamma is lovers Gramas Forbs

This publication reports research involving pesticides and herbicides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides and herbicides can be injurious to humans, domestic animals, desirable plants, honeybees and other pollinating insects, and fish or other wildlife -- if they are not handled or applied properly. Use all pesticides and herbicides selectively and carefully. Follow recommended practices for the disposal of surplus materials and containers.

Trade names and company names are used for the benefit of the reader and do not imply endorsement or preferential treatment by the U. S. Department of Agriculture.

# About The Forest Service. . . .

As our Nation grows, people expect and need more from their forests—more wood; more water, fish and wildlife; more recreation and natural beauty; more special forest products and forage. The Forest Service of the U. S. Department of Agriculture helps to fulfill these expectations and needs through three major activities:

- Conducting forest and range research at over 75 locations ranging from Puerto Rico to Alaska to Hawaii.
- Participating with all State forestry agencies in cooperative programs to protect, improve, and wisely use our Country's 395 million acres of State, local, and private forest lands.
- Managing and protecting the 187-million acre National Forest System.

The Forest Service does this by encouraging use of the new knowledge that research scientists develop; by setting an example in managing, under sustained yield, the National Forests and Grasslands for multiple use purposes; and by cooperating with all States and with private citizens in their efforts to achieve better management, protection, and use of forest resources.

Traditionally, Forest Service people have been active members of the communities and towns in which they live and work. They strive to secure for all, continuous benefits from the Country's forest resources.

For more than 60 years, the Forest Service has been serving the Nation as a leading natural resource conservation agency.